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Electromagnetic Spectrum Occupancy Study of a Potential Transmitter Site for the HF Active Auroral Research Program (HAARP)

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13. ABSTRACT *(Maximum 200 words)*

This report presents the results of measurements conducted by the Naval Research Laboratory in May and June 1993. The purpose of the measurements was to ascertain the radio frequency occupancy in the immediate vicinity of the proposed High Frequency Active Auroral Research Program (HAARP) facility to be constructed in the Gakona, Alaska area. The HAARP facility will consist of a large planar array of antennas excited by phased high power transmitters operating in the lower portion of the HF band (2.8 to 8 MHz). The existing electromagnetic spectrum usage in the vicinity of Gakona was measured in order to assess the potential for electromagnetic interference problems arising from the HAARP facility. The measurements covered the frequency spectrum from 2 MHz to 1000 MHz. Data was collected for a period of 17 days in May and early June 1993. There are a large number of users in the HF band and data shows a normal diurnal pattern of energy increase in the lower portion of the band in the nighttime hours. The number of users decreases with increasing frequency because the propagation path at higher frequencies is dependent upon line-of-sight signal paths. Gakona is a very rural area and is separated by hilly terrain from surrounding residential and commercial activities. Above the HF band, the most prominent signal identified is a 152 MHz transient signal that saturates the signal path of our measurement apparatus. The signal is so strong that it produces harmonics throughout the measurement band and distorts the display of the data. Another strong feature that is sometimes observed is a 450 MHz signal.

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ELECTROMAGNETIC SPECTRUM OCCUPANCY STUDY OF A POTENTIAL TRANSMITTER SITE FOR THE HF ACTIVE AURORAL RESEARCH PROGRAM (HAARP)

I. INTRODUCTION

The High Frequency Active Auroral Research Program (HAARP) is a Congressionally-mandated program, jointly administered by the Office of Naval Research and the Phillips Laboratory, Department of the Air Force. Under the HAARP program, a high power radio frequency transmitting facility will be constructed in Alaska to permit long term scientific studies of the Earth's ionosphere under all conditions of geomagnetic activity. The HAARP facility will provide sufficient energy densities in the ionosphere to facilitate investigations of such diverse areas of research as:

- The generation of Extremely Low and Very Low Frequency (ELF and VLF) waves in the auroral region for special communication applications.

- The acceleration of electrons to produce optical and infra-red (IR) emissions.

- The production of field aligned irregularities of sufficient electron density to scatter radio waves.

The primary candidate location for the construction of this transmitting facility is at Gakona, Alaska (approximately 62° 24.5' North, 145° 9.3' West), which is located approximately 165 miles northeast of Anchorage, Alaska. The Air Force had planned to install an over-the-horizon radar (OTHR) at the Gakona location. However, downsizing of the OTHR program resulted in the decision not to install the radar in Gakona and the site was made available to HAARP.

Since HAARP is a high power radio frequency transmitting facility, there exists the potential for the generation of electromagnetic interference (EMI) at both the primary operating frequency and its harmonics. The HAARP facility is able to operate in the band from 2.8 to 10 MHz. The transmitting antenna array is being designed to have a mode of operation with very low sidelobes relative to the main antenna beam. However, some residual energy may still be radiated from the sidelobes of the antenna array. In order to assess the potential for EMI problems arising from the HAARP facility, a survey was initiated in the vicinity of Gakona to sample existing electromagnetic spectrum usage.

This report describes measurements conducted to ascertain the radio frequency occupancy in the immediate Gakona area. The approach was to conduct survey measurements to identify the frequencies most often used and to determine the time of day when those frequencies were active. The measurements covered the frequency spectrum from 2 MHz to 1000 MHz, divided into four spectrum analyzer subbands.

II. MEASUREMENT SYSTEM

The block diagram of the equipment installed at the Gakona location is shown in Fig. 1. The antenna for the High Frequency (HF) band, 2 to 20 MHz, utilized an active 1.4 meter whip antenna. For the remainder of the frequency band, 20 to 1000 MHz, a 1.7 meter wideband omni-directional discone antenna was used. The HF antenna is manufactured by Stoner Communications and is the Model Dymek DA 100D All Wave Receiving Antenna. The omni-directional discone antenna is manufactured by Sigma

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Euro-Com and is the Model SE 1300. The two antennas were installed on the top of a crank-up tower and elevated to a height of 19.8 meters above the existing terrain. The height approximated the elevation of the antenna

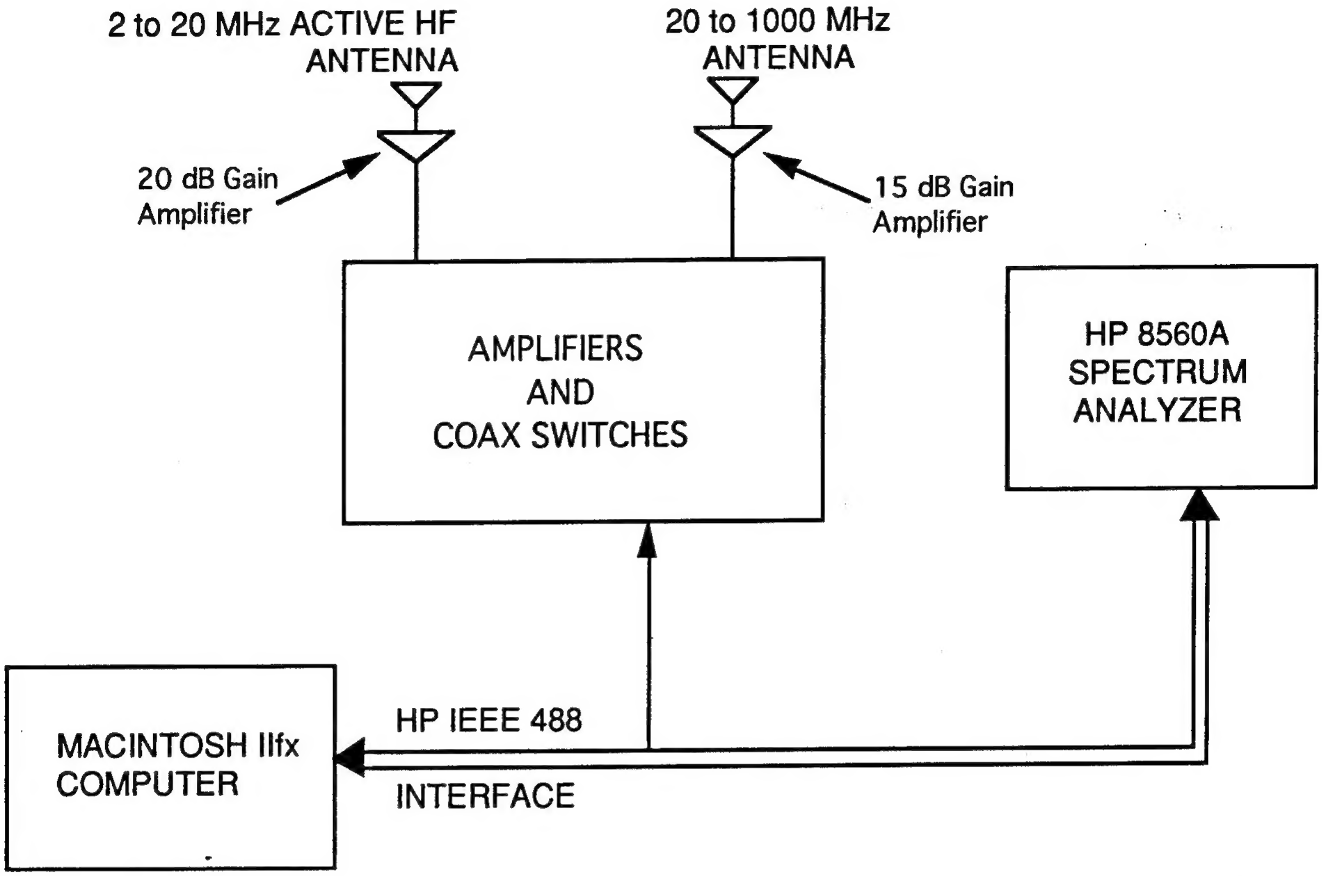


FIGURE 1. Measurement system block diagram.

array for the proposed transmitting facility. The two antennas were separated horizontally by approximately 2.4 meters, on the top of the tower. The signals from the antennas were connected to an Amplifier and Coax Switch box through 30.5 meters of coaxial cable. RG-223 coaxial cable was used for the HF portion of the signal path and RG-214 was used for the remainder of the band. A more detailed functional block diagram, including the Amplifier and Switch box signal path, is shown in Fig. 2. A telephone is used for remote operation of the data collection system and downloading the data to NRL in Washington, D. C.

Since coaxial cables attenuate RF amplitudes and spectrum analyzers have poor noise figures, sufficient amplification between the antennas and the spectrum analyzer was provided in each portion of the frequency band to raise the signal levels above the internal noise level of the spectrum analyzer. The signal path was divided in two branches, the HF band in the 2 to 20 MHz range and the remainder of the frequencies surveyed, 20 MHz to 1000 MHz. The upper portion of the surveyed frequencies was further subdivided into two subbands, one path for signals below 300 MHz and another

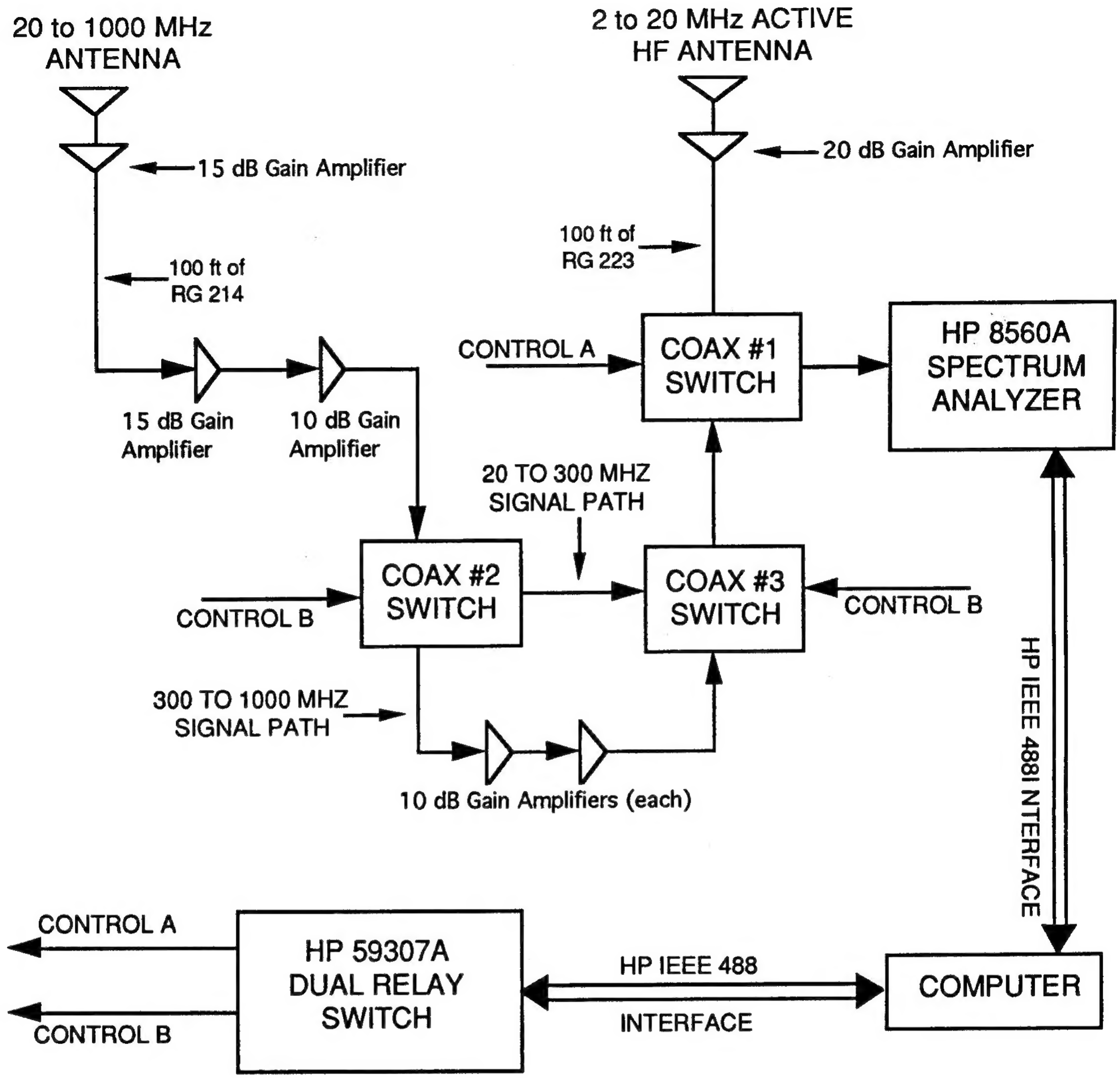


FIGURE 2. Signal path and switch control

for above 300 MHz. The computer generated "A" and "B" signals control the coax switches and the amount of amplification in each portion of the frequency spectrum. The HF active whip antenna system provides approximately 20 dB of gain in the frequency band from 100 kHz to 29 MHz. No other amplification was required for this frequency band and the signal path to the spectrum analyzer is through coax switch # 1. In order to overcome the loss in the coaxial cable, a 15 dB gain, low noise amplifier was installed within 1 meter of the omni antenna. Additional amplification is provided by the 15 dB and 10 dB gain amplifiers that are common components to the signal path above 20 MHz. Above 300 MHz, an additional 20 dB of gain is provided by adding two 10 dB

amplifiers in the signal path. The spectrum analyzer subbands and the overall system gain (excluding any antenna gain) are presented in Table 1.

Since coaxial cables attenuate RF amplitudes and spectrum analyzers have poor noise figures, sufficient amplification between the antennas and the spectrum analyzer was provided in each portion of the frequency band to raise the signal levels above the internal noise level of the spectrum analyzer. The signal path was divided in two branches, the HF band in the 2 to 20 MHz range and the remainder of the frequencies surveyed, 20 MHz to 1000 MHz. The upper portion of the surveyed frequencies was further subdivided into two subbands, one path for signals below 300 MHz and another for above 300 MHz. The computer generated "A" and "B" signals control the coax switches and the amount of amplification in each portion of the frequency spectrum. The HF active whip antenna system provides approximately 20 dB of gain in the frequency band from 100 kHz to 29 MHz. No other amplification was required for this frequency band and the signal path to the spectrum analyzer is through coax switch # 1. In order to overcome the loss in the coaxial cable, a 15 dB gain, low noise amplifier was installed within 1 meter of the omni antenna. Additional amplification is provided by the 15 dB and 10 dB gain amplifiers that are common components to the signal path above 20 MHz. Above 300 MHz, an additional 20 dB of gain is provided by adding two 10 dB amplifiers in the signal path. The spectrum analyzer subbands and the overall system gain (excluding any antenna gain) are presented in Table 1.

TABLE 1

SUBBAND FREQ (MHz)	MEASUREMENT FREQ (MHz)	TOTAL SUBBAND GAIN (dB)
2 to 20	10	16.7
20 to 100	100	37.5
100 to 300	300	34.8
300 to 1000	500	51.8

A MacIntosh IIfx computer controls the switching of the signal path, sets the parameters of the spectrum analyzer and stores the data on an internal hard disk. All data are relayed to NRL in Washington, D. C. via dial-up telephone lines at 9600 baud. Two levels of remote control are used to operate the field data measurement system. AppleTalk Remote Access© software and modems are used for communications between the remote computer in Alaska and the local computer. Additional software is used to control the remote computer and exchange files (data or software programs) between the local computer and the remote system. With this software, the local computer can remotely operate the Alaska equipment. The remote computer's video is displayed on the screen of the local terminal and all local operations are duplicated at the remote system. Since the spectrum analyzer settings are under software control, this method allows alteration of the spectrum analyzer configuration to provide flexibility to perform the survey measurements described here. In addition, the spectrum analyzer can be reconfigured to concentrate on particular portions of the frequency spectrum that are most often occupied. The combination of computer hardware and

controller software provides a very flexible and cost effective technique to collect field data without the expense of personnel traveling to the field location to operate a system. The approach is not completely refined and we have experienced failures that have terminated data collection at unscheduled times by interrupting program flow in the remote computer. However, experience with this data collection technique is identifying problem areas that can be corrected in future designs. (For example, errors have been generated by leaving unnecessary software active in the remote computer's memory.)

The data collection system is intended to be operated continuously. However, unscheduled system interruptions have resulted in "holes" in the data. Data collection was initiated on 21 May 1993. The survey phase of the collection was prematurely terminated on 5 June 1993. The collection termination was scheduled for 7 June but an amplifier failure forced a premature ending. The amplifier failure occurred in the 20 to 1000 MHz signal path and was traced to the amplifier near the top of the 19.8 meter tower. The reason for this failure has not been determined.

III. MEASUREMENT TECHNIQUE

Since each spectrum analyzer sweep involved 601 data points, and since approximately 106 spectrum analyzer sweeps are recorded each hour, it was essential to establish a means of compressing the data. Limiting the amount of data simplified the data collection process, the required data storage demands and the time required to transfer the data from the remote system to NRL. The approach used in these measurements was to collect hour long data files for each of the frequency subbands, in which only the maximum amplitude at each frequency was retained. This is analogous to a "maximum hold" measurement for each frequency. This method provided a broad overview of the strongest amplitude signals present during each hour of the day.

The data are shown in Figs. 3 to 38 and are plotted using a decade quantifying color coding scheme to indicate the value of the "max hold" amplitude in dBm. The decades were selected to represent amplitudes from -70 to 0 dBm, except for the highest quantifying level which represents amplitudes for 2 decades from -20 to 0 dBm. The data presented in this report have not been scaled for the variation in signal path gain. Therefore, amplitudes for each figure are relative values. The black areas of each plot represent amplitudes below -70 dBm and when the black data interrupts "normal" data the black color indicates periods when no data was collected. Each plot represents 2 days (48 hours) of data for each subband measured. Frequency, in MHz, is the abscissa axis and date/time, in date, hour and minute, is ordinate axis. Times are given in local time in Gakona, Alaska (AST). For presentation purposes (to avoid pixel color bleed), the data from three adjacent frequencies have been plotted as a single value that represents the total signal power of all three frequencies. While this methodology dilutes the frequency resolution of the data, the general, survey nature of these measurements is preserved. Follow on measurements will concentrate on more narrow subbands and increased frequency resolution of the measured data and will be reported separately.

The spectrum analyzer parameters for the measurements are shown in Table 2. These analyzer parameters are a compromise between available analyzer settings and the 601 frequency data points.

TABLE 2

SPECTRUM ANALYZER PARAMETERS 21 May to 5 JUNE 1993

SUBBAND FREQ (MHz)	ANALYZER RESOLUTION BANDWIDTH (kHz)	ANALYZER SWEEP TIME (seconds)	ANALYZER FREQUENCY SPACING (kHz)
2 to 20	30	0.06	30
20 to 100	100	0.08	133.33
100 to 300	300	0.02	333.33
300 to 1000	1000	0.02	1166.67

IV. DISCUSSION OF THE DATA

A. Subband #1 - HF Data - 2 to 20 MHz - Figs. 3 to 11

The main US allocations authorized for this subband are some short wave broadcasters, communication and navigation services for both aeronautical and maritime users and users of the amateur radio bands. HF is a frequently used broadcast band for long haul, beyond line-of-sight communications made possible by skywave propagation via reflection from the ionosphere. The data for this HF subband shows strong signals spread across the most of this band. One common characteristic of usage in HF is the migration from higher to lower frequencies during the nighttime hours, when the maximum frequency of operation supported by skywave propagation decreases. During daytime hours the F layer of the ionosphere supports propagation at higher frequencies. The data shows this diurnal effect with higher amplitudes, indicating more emitters, bunched at the lower portion of the spectrum during the hours from about 2300 to 0600. The resolution bandwidth of the measurements was 30 kHz. If a majority of the emitters in this band are voice circuits, then the bandwidth for a single emitter is about 3 kHz and the higher amplitudes of the nighttime measurements are indicative of the higher number of emitters in the same frequency "bin".

Data for 27 and 28 May, in Fig. 6, is noteworthy because this diurnal pattern is not as pronounced as most of the other data. The reduction in amplitude is on the order of 10 to 20 dB. A "mild" magnetic storm could have caused an ionospheric disturbance that degraded HF propagation conditions, especially at this relatively high latitude. The recovery of the ionosphere to "normal" propagation conditions is shown in the data for 29 and 30 May, Fig. 7, where the diurnal pattern is clearly discernible. Geomagnetic data[1] for this period indicates that the Pt. Barrow, Alaska K-indices were in the range of 0 to 2, increased to 3 to 5 for 27 May, remained in the 3 to 4 range for 28 and 29 May and was back down to the 2 to 3 range on 30 May. A similar disappearance of the diurnal pattern is seen in the data for 3 through 5 June, Fig. 10 and 11. The

[1] Preliminary Report and Forecast of Solar Geophysical Data, SESC PRF 926, 1 June 1993, U. S. Dep of Commerce, Space Environment Services Center, Boulder, CO 80303-3328.

geomagnetic data[2] for the period of 3 through 5 June indicates that the Pt. Barrow, Alaska K-indices were in the range of 3 to 7. For 3 June, the K-indices started at 1 and increased to a maximum of 4 later in that day. K was initially at 4 for 4 June, increased to 6 later in the day and remained in the 5 to 7 range for 5 June. Recovery from this disturbed ionospheric condition is not shown in the data since data collection in this subband was terminated before the K-indices returned to lower values.

The data collection period for 21 May at 13:21 shows anomalous amplitudes throughout this band. Further investigation for the other subbands also shows anomalous amplitudes indicating broad band interference for the entire frequency range observed. The source of this interference is unknown but it contaminates the data so as to be unusable for that hour. Recall that the measurement technique used is a maximum hold amplitude method. Therefore, broadband interference may be present for a short period of time and yet dominate the entire hour of the measurement. The data from 22 May at 12:26 is also contaminated by broadband interference but at a reduced amplitude relative to the 21 May, 13:21 data. This broadband interference could be from the water pump at the Gakona site. During installation of the system at Gakona, when this water pump was activated, broadband interference was observed on the spectrum analyzer.

B. Subband #2 - HF/VHF Data - 20 to 100 MHz - Figs. 12 to 20

The main US allocations authorized for this subband include some low band land mobile services (30 to 50 MHz), the VHF low band television broadcasting (54 to 88 MHz), about half of the FM broadcasting band (88 to 100 MHz)[3] and amateur radio The large number emitters in the frequency range from about 20 to 40 MHz needs to be investigated further but may be associated with the amount of amplification in the signal path. Referring to Fig. 2 and Table 1, the amplification in subband #1 was 16.67 dB and was 37.5 dB in this HF/VHF subband which is an increase in signal amplification of 20.88 dB. Also recall that the data is not scaled for variations in signal path gain. The apparent increase in emitters may be due to this additional gain, raising background noise amplitudes into the red/pink color range. Taking this added gain into account, this subband is relatively quiet, especially in relation to subband #1. Subband #2 is often above the frequency band where ionospheric reflection for propagation is possible and line-of sight propagation begins to dominate. No discernible diurnal dependence is present in the data. There are a number of frequencies that are in fairly constant use during the entire 17 days of data displayed in Figs. 12 to 20. Those frequencies are 28, 34, 40, 46 to 48 52, 55 to 58, and 60 MHz. Very little activity is seen above for any frequency above 60 MHz.

One of the local television stations in subband #2 is channel 5, 76 to 82 MHz. Television transmissions, originating in Anchorage, are received in the town of Glenallen via relay retransmission. Gakona is about 35 miles from Glenallen and is separated from Glenallen by hilly terrain. The data for subband #2 does not show any measurable energy in the 76 to 82 MHz range, indicating that the terrain prevents the channel 5

[2] Preliminary Report and Forecast of Solar Geophysical Data, SESC PRF 927, 8 June 1993, U. S. Dep of Commerce, Space Environment Services Center, Boulder, CO 80303-3328.

[3] Compiled from USA Frequency Allocation 10 kHz to 4 GHz, Motorola's RF semiconductors chart, referenced to Federal Regulations CFR 47 Part 2 - Frequency Allocations and Reference Data for Radio Engineers, fifth edition, 1968.

television signal from reaching Gakona. Subband #2 includes a portion of the FM broadcast band and Glenallen is serviced by a retransmission of a National Public Radio affiliate from Fairbanks at 92.1 MHz. The data does not show any energy for this frequency and the same conclusion as pertains to the channel 5 television frequency applies.

Since the first phase of this investigation was to determine the general occupancy of the frequency spectrum, the actual identity of each of the emitters identified in the measurements was not attempted. As previously discussed, broadband interference is present in the data for 21 May at 13:21, Fig. 12. In addition, the data from 22 May at 12:26, Fig. 12, 1 Jun at 10:10, Fig. 17, 2 June at 07:28, Fig. 18, and 4 June at 13:59, Fig. 19, all are contaminated by broadband interference.

C. Subband #3 - VHF Data - 100 to 300 MHz - Figs. 21 to 29

The main US allocations authorized for this subband are the upper portion of the FM broadcasting band (100 to 108 MHz), aeronautical communication and navigation services (108 to 145 MHz), amateur radio (144 to 148 MHz), high band land mobile services (149 to 172 MHz), VHF high band television broadcasting (174 to 216 MHz), some maritime communication and navigation services (216 to 220 MHz) and military users (225 to 300 MHz). The major regions of this subband that show emitters are : 100 to 105 MHz, 112, 114, 115, 118 to 132, 150 to 172, 188 and some energy in the vicinity of 288 to 295 MHz.

The frequency range from 110 MHz to, nearly, 160 MHz shows high occupancy during all times of the day. In the lower part of this frequency range, the emitters are believed to be aeronautically related and the occupancy is somewhat diurnal. The proximity of small, general aviation airports and associated air traffic would be responsible for the observed usage.

The most prominent feature for this data is the very large signal that is present at about 152 MHz. The amplitude of this 152 MHz signal is in the largest quantification level presented in the data (0 to -20 dBm). An example of this 152 MHz signal is found in the data for 21 May at both 15:21 and 16:21, Fig. 21. The spectrum analyzer parameters for this data were set to have the highest displayed value at -10 dBm. The amplitude of the 152 MHz signal has been determined to be -8 dBm, which means that this signal saturated the spectrum analyzer. Other evidence from subband #4, which is discussed in that section of this report, indicates that there are multiple frequencies, up to 1000 MHz, spaced 152 MHz apart, with amplitudes between -8 to -13 dBm. This 152 MHz signal has saturated an amplifier in the signal path for both this subband and subband #4. The -8 dBm signal level for this signal at is present in the hour data blocks for less than 1 percent of that hour's data. Since the hour data blocks are "max hold" measurements, this very transient, large amplitude signal dominates the data for those hours. Additional evidence of this signal is present in the data for this subband for every day of the measurements (21 May to 5 June) except for 22, 29 and 31 May and 5 June. A very curious fact is that 22 May and 5 June are Saturdays and 29, 30 and 31 May is the Memorial day weekend. In addition, most of the occurrences of this signal is for times of day that could be called normal working hours. Therefore, the source of this signal seems to be an emitter that does not radiate on Saturdays and holidays. An explanation of the absence of the 152 MHz signal on Saturdays and holidays requires further investigations to determine if the non-working hours pattern is repeated

Energy is also present in the 288 to 295 MHz range in the data for 21 May at both 15:21 and 16:21, Fig. 21. Further examination reveals that this energy is only present when the 152 MHz signal is in the 0 to -20 dBm amplitude range. The 288 to 295 MHz signals are not harmonics of the 152 MHz frequency but could be the result of non-linearities in the saturated amplifier mixing with other lower frequencies in the spectrum of this subband. There is energy in the -20 to -30 dBm level in the 130 to 140 MHz rang for most of the occurrences of the 288 to 295 MHz signals. Data taken with a saturated amplifier are not calibrated measurements and can produce strange results.

In addition to the large 152 MHz signal, energy is often observed in the 270 to 300 MHz range. These signals at the upper end of subband #3 are always associated with the presence of the large 152 MHz signal. The frequencies and amplitudes of the largest of these signals for the data from 1 June, 11:10, Fig. 36, was found to be 278 MHz, -35 dBm, and 289 MHz, -35 dBm. We believe that these signals are the result of non-linear mixing of some energy in the 120 to 140 MHz range with the 152 MHz saturating signal. These signals at the upper end of subband # 3 are artificial and not the result of emitters at these frequencies.

Signals are present in the 150 to 163 MHz range in the data for 29 and 30 May, Fig. 25, two of the days when the large amplitude 152 MHz signal is absent. This data shows a fairly strong signal at about 150 MHz that is present for most of this 48 hour period. In addition other substantial emitters are present at about 158 and 160 MHz. All of these signals are also present in most of the other data but the 152 MHz signal tends to capture the viewer's attention and dominate the displayed data.

Two of the local television stations in this subband are channels 7 and 13, 174 to 180 and 210 to 216 MHz, respectively. As was the case for subband #2, the television transmissions are received in Glenallen via relay retransmission from Anchorage and terrain blockage prevents any reception of these signals at Gakona. However, there is a signal at 188 MHz that is always present in the data for all 17 days. The video subcarrier for channel 7 is 188 MHz. Since the television transmissions are "blocked" by terrain, this 188 MHz must be a "local" signal.

As was found in subbands #1 and 2, broadband interference is present in the data. The measurements for 21 May at 13:21 and 22 May at 12:26, Fig. 21, 2 June at 07:28, Fig. 27 and 4 June at 13:59, Fig. 28, all are examples of data contaminated by broadband interference.

D. Subband #4 - UHF Data - 300 to 1000 MHz - Figs. 30 to 38

The main US allocations authorized for this subband are the military users (300 to 328 MHz), aeronautical communication and navigation services (328 to 335 MHz), military users (335 to 400 MHz), scientific and space users (400 to 410 MHz), military users (410 to 460 MHz), amateur radio (440 to 450 MHz) and UHF television broadcasting (470 to 890 MHz). The increase in overall signal amplitude is due to the additional amplification incorporated into the signal path. The system amplification in subband #3 is 34.8 dB (measured at 300 MHz) and the gain for subband #4 is 51.8 dB (measured at 500 MHz). The added 17 dB gain for subband #4 and the predominately red color (-30 to -40 dBm) signal amplitudes from about 300 to 450 MHz correspond to blue/green (-50 to -70 dBm) signal amplitudes for subband #3.

There are only two main emitters identified in the data for this subband. One is in the vicinity of 450 MHz, with an occasional additional source at about 467 MHz. The other is a signal at approximately 966 MHz. The 450 MHz signal may be reception of forward scatter of the BMEWS radar from Clear Air Force Base, near Fairbanks. This type of propagation is very questionable but is occasionally possible.

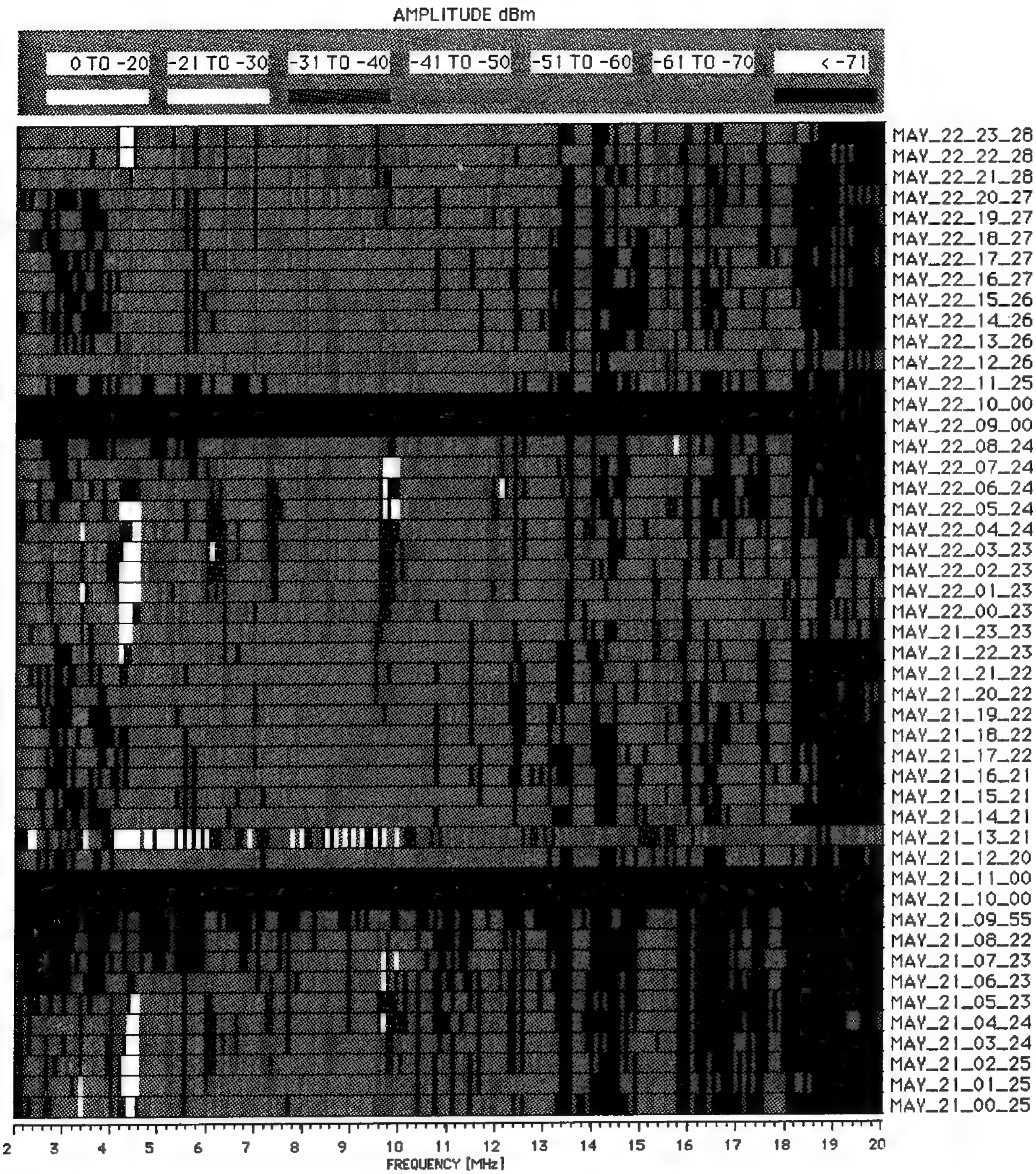
There is also the possibility that this signal is received line-of-sight from an aircraft air search radar or an amateur radio repeater. The Alyeskia oil pipe line is known to operate a repeater in this frequency range. Forward scatter from a radar near Fairbanks would be received at Gakona at very low amplitude and this is considered an unlikely source. The 966 MHz signal is probably a terrestrial microwave relay user for communications. Because of the importance of the frequency range near 450 MHz to the HAARP program, additional detailed measurements are planned.

The other prominent feature of many of the measurements for this subband is the energy that seems to "fill" a large portion of the frequencies of this subband. The frequencies of the peak amplitude for each of these signals is 304, 456, 608, 760 and 912 MHz. The frequency spacing of these signals is 152 MHz and the signal level amplitudes are between -8 and -13 dBm, which indicates spectrum analyzer saturation. The fact that these signals are separated by 152 MHz indicates that an amplifier in the signal path was overloaded by the large, transient 152 MHz signal of subband #3. The subband # 3 data for 25 May, Fig. 23, shows that the 152 MHz signal is present for all data for 10:15 to 16:56 (except for the no data hour of the 11:00 block). Comparison with subband #4 data for 25 May, Fig. 32, shows that these signals separated by 152 MHz are present for every hour from 10:15 to 16:56 except the 15:57 data block. It could be that the 152 MHz signal was slightly lower in amplitude for the 15:57 data, did not saturate the amplifier and therefore did not produce the harmonics seen in subband #4. Future measurements can be designed with shorter time data blocks to separate out transient or momentary signals The purpose of the measurements reported here is to survey for "common" spectrum users in a very broad sense and a natural outcome is to identify areas of investigation for finer temporal and spectral examinations.

V. Conclusions and Recommendations

A system to remotely examine the electromagnetic spectrum occupancy in the vicinity of Gakona, Alaska from 2 to 1000 MHz has been installed. Data are presented in this report for system operation for a period of 17 days in May and early June 1993. The data in the HF band shows a normal diurnal pattern of energy increase in the lower portion of the band in the nighttime hours. There are a large number of users in the HF band. The number of users decreases as frequency increases because the propagation path at higher frequencies is dependent upon line-of-sight signal paths. The location of Gakona is a very rural area and is separated by hilly terrain from surrounding residential and commercial activities. The most predominant signal identified above the HF band is a 152 MHz transient signal that saturates the signal path of the measurement apparatus. The signal is so strong that it interacts with the monitoring system to produce harmonics throughout the measurement band and distorts the display of the data by dominating the data plots. Another predominant feature is a 450 MHz signal that is sometimes observed.

Data collection will continue to determine if this limited data set is truly a representative sampling of the spectrum occupancy at Gakona. Future measurements will concentrate on avoiding saturation from the 152 MHz signal and determine time duration and time-of-day of this signal. In addition, finer scaled measurements of the 100 to 200 MHz range will be made to help identify the potential of interference from HAARP to aircraft communications. (There is concern about disruption of communication with Alaskan general aviation pilots in this rural area.) Finer scale temporal and spectral measurements will help identify who may be impacted by the HAARP transmissions. Mitigation techniques can then be examined to allow coexistence of both HAARP and frequency spectrum user without adverse impact on either.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-31 TO -40
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-51 TO -60
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MAY_21_08_22
MAY_21_07_23
MAY_21_06_23
MAY_21_05_23
MAY_21_04_24
MAY_21_03_24
MAY_21_02_25
MAY_21_01_25
MAY_21_00_25
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
FREQUENCY [MHz]

FIGURE 3

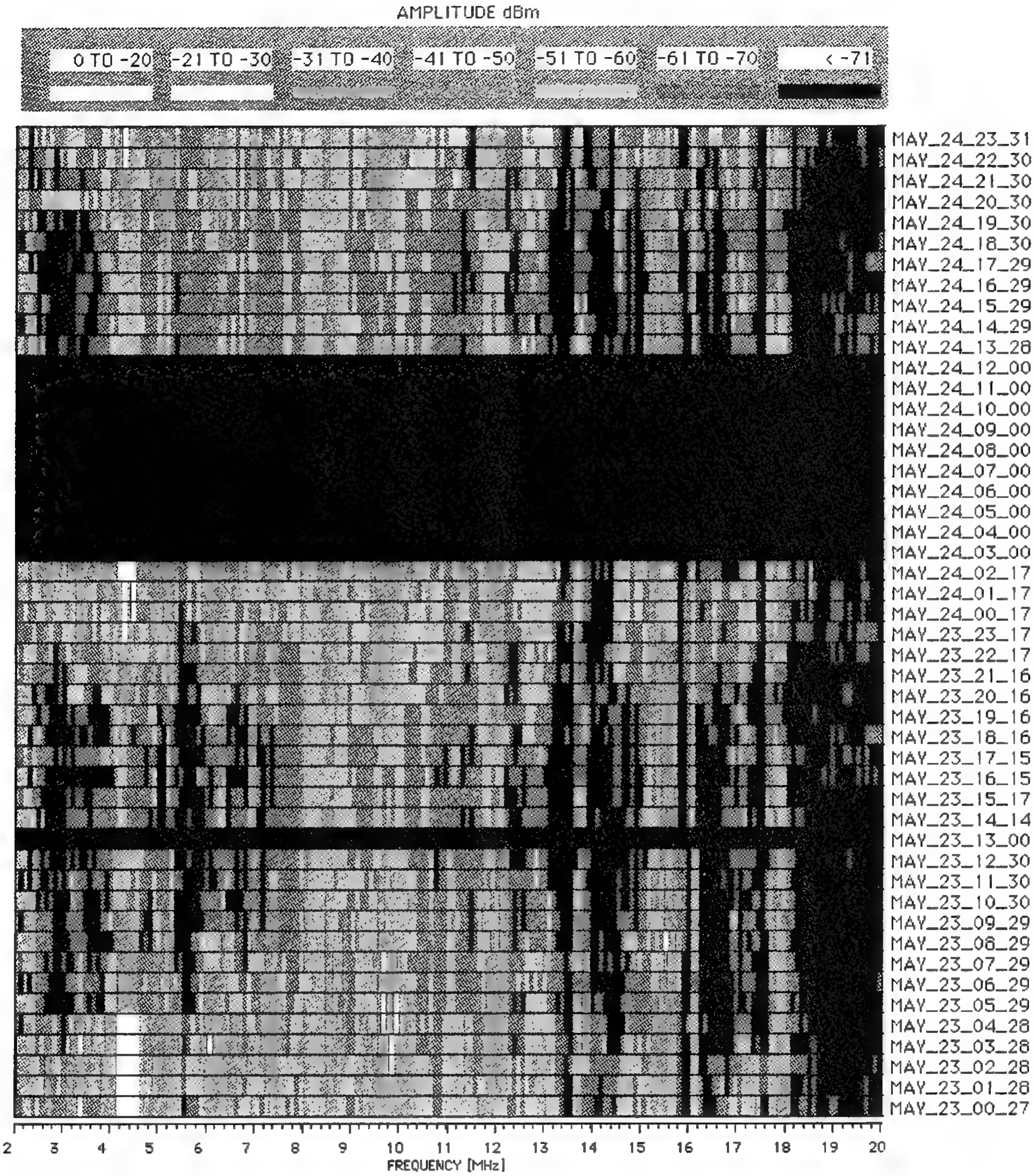

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
MAY_24_23_31
MAY_24_22_30
MAY_24_21_30
MAY_24_20_30
MAY_24_19_30
MAY_24_18_30
MAY_24_17_29
MAY_24_16_29
MAY_24_15_29
MAY_24_14_29
MAY_24_13_28
MAY_24_12_00
MAY_24_11_00
MAY_24_10_00
MAY_24_09_00
MAY_24_08_00
MAY_24_07_00
MAY_24_06_00
MAY_24_05_00
MAY_24_04_00
MAY_24_03_00
MAY_24_02_17
MAY_24_01_17
MAY_24_00_17
MAY_23_23_17
MAY_23_22_17
MAY_23_21_16
MAY_23_20_16
MAY_23_19_16
MAY_23_18_16
MAY_23_17_15
MAY_23_16_15
MAY_23_15_17
MAY_23_14_14
MAY_23_13_00
MAY_23_12_30
MAY_23_11_30
MAY_23_10_30
MAY_23_09_29
MAY_23_08_29
MAY_23_07_29
MAY_23_06_29
MAY_23_05_29
MAY_23_04_28
MAY_23_03_28
MAY_23_02_28
MAY_23_01_28
MAY_23_00_27
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
FREQUENCY [MHz]

FIGURE 4

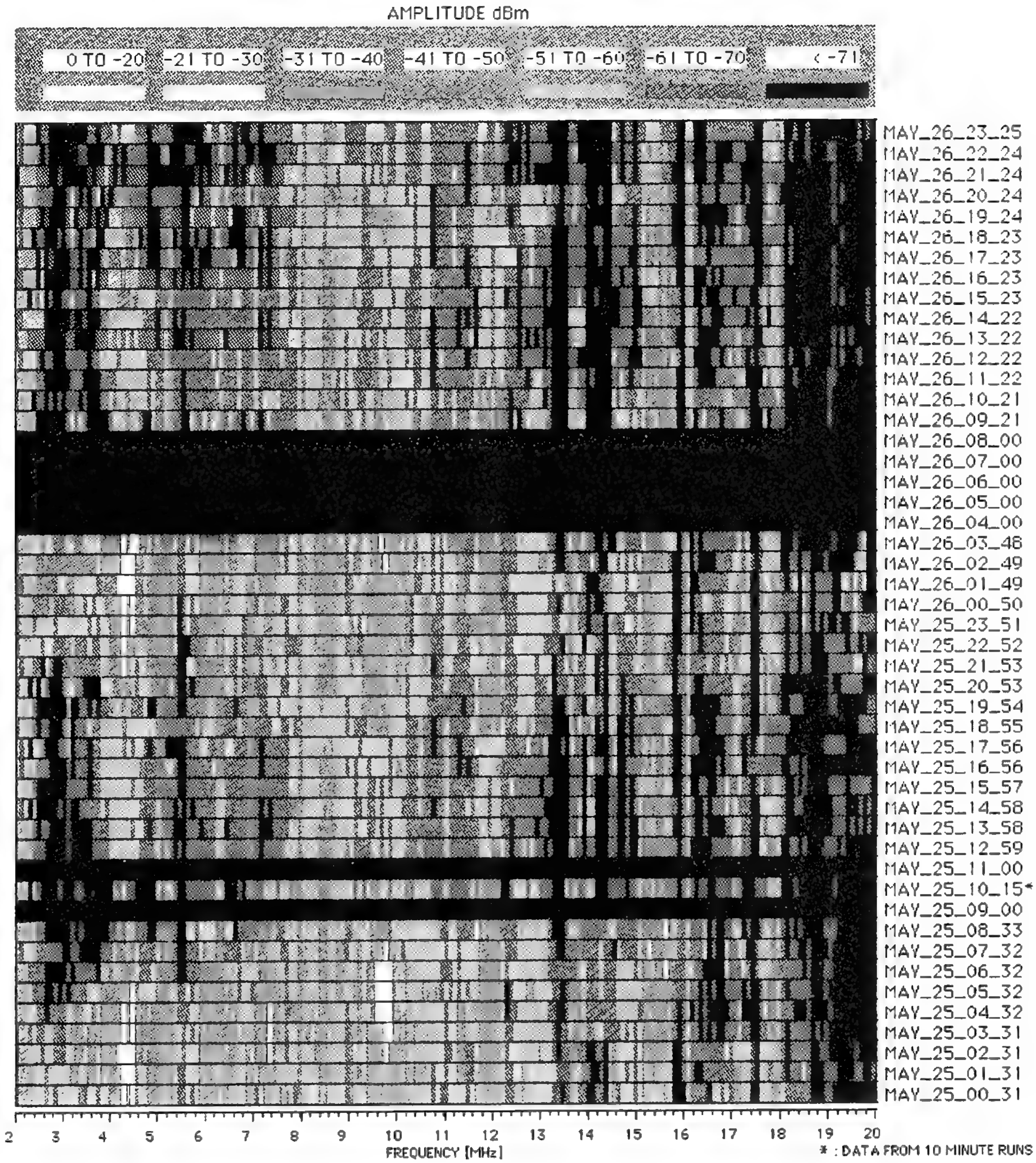

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
MAY_26_23_25
MAY_26_22_24
MAY_26_21_24
MAY_26_20_24
MAY_26_19_24
MAY_26_18_23
MAY_26_17_23
MAY_26_16_23
MAY_26_15_23
MAY_26_14_22
MAY_26_13_22
MAY_26_12_22
MAY_26_11_22
MAY_26_10_21
MAY_26_09_21
MAY_26_08_00
MAY_26_07_00
MAY_26_06_00
MAY_26_05_00
MAY_26_04_00
MAY_26_03_48
MAY_26_02_49
MAY_26_01_49
MAY_26_00_50
MAY_25_23_51
MAY_25_22_52
MAY_25_21_53
MAY_25_20_53
MAY_25_19_54
MAY_25_18_55
MAY_25_17_56
MAY_25_16_56
MAY_25_15_57
MAY_25_14_58
MAY_25_13_58
MAY_25_12_59
MAY_25_11_00
MAY_25_10_15*
MAY_25_09_00
MAY_25_08_33
MAY_25_07_32
MAY_25_06_32
MAY_25_05_32
MAY_25_04_32
MAY_25_03_31
MAY_25_02_31
MAY_25_01_31
MAY_25_00_31
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
FREQUENCY [MHz]
* : DATA FROM 10 MINUTE RUNS

FIGURE 5

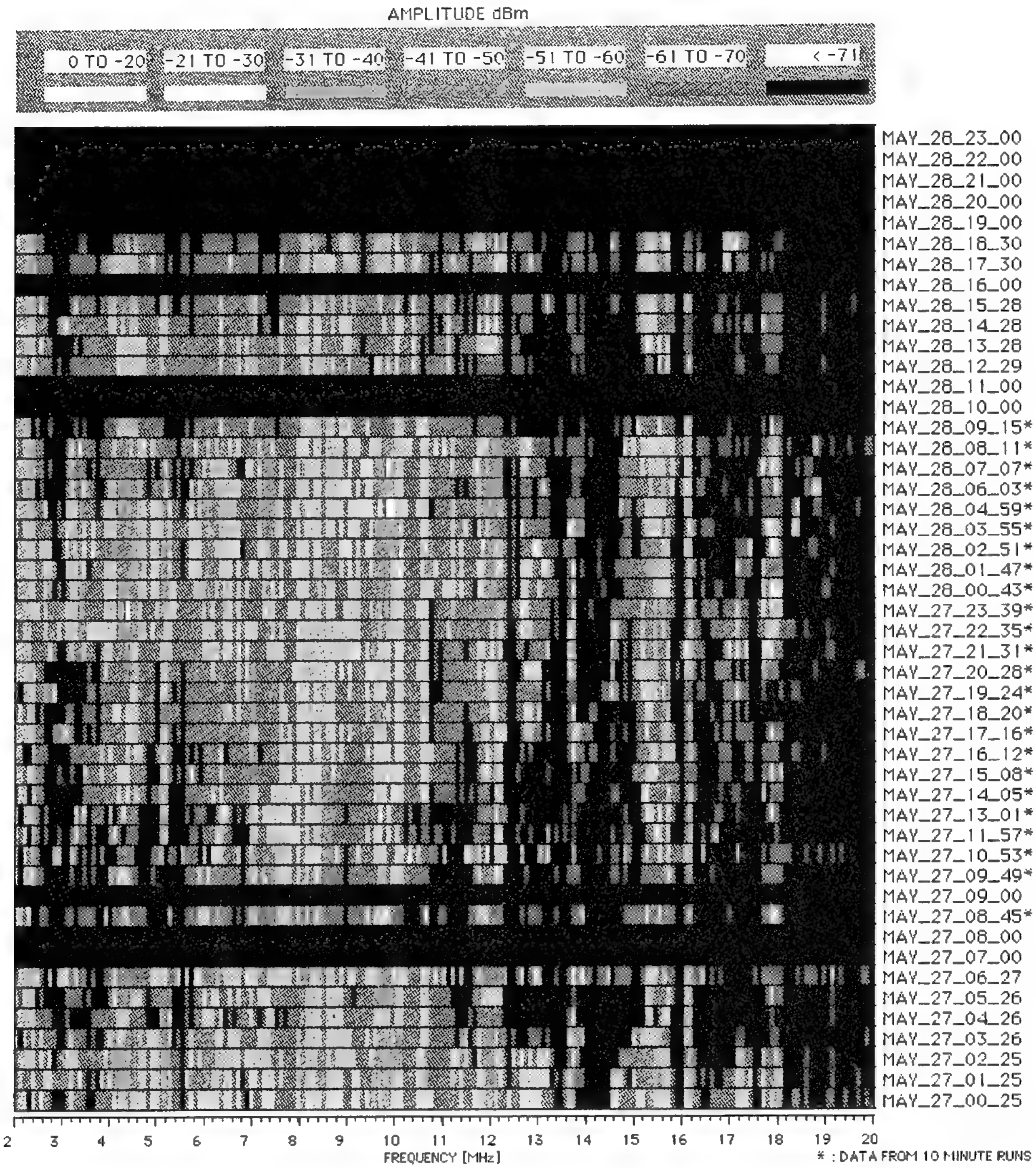

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
MAY_28_23_00
MAY_28_22_00
MAY_28_21_00
MAY_28_20_00
MAY_28_19_00
MAY_28_18_30
MAY_28_17_30
MAY_28_16_00
MAY_28_15_28
MAY_28_14_28
MAY_28_13_28
MAY_28_12_29
MAY_28_11_00
MAY_28_10_00
MAY_28_09_15*
MAY_28_08_11*
MAY_28_07_07*
MAY_28_06_03*
MAY_28_04_59*
MAY_28_03_55*
MAY_28_02_51*
MAY_28_01_47*
MAY_28_00_43*
MAY_27_23_39*
MAY_27_22_35*
MAY_27_21_31*
MAY_27_20_28*
MAY_27_19_24*
MAY_27_18_20*
MAY_27_17_16*
MAY_27_16_12*
MAY_27_15_08*
MAY_27_14_05*
MAY_27_13_01*
MAY_27_11_57*
MAY_27_10_53*
MAY_27_09_49*
MAY_27_09_00
MAY_27_08_45*
MAY_27_08_00
MAY_27_07_00
MAY_27_06_27
MAY_27_05_26
MAY_27_04_26
MAY_27_03_26
MAY_27_02_25
MAY_27_01_25
MAY_27_00_25
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
FREQUENCY [MHz]
* : DATA FROM 10 MINUTE RUNS

FIGURE 6

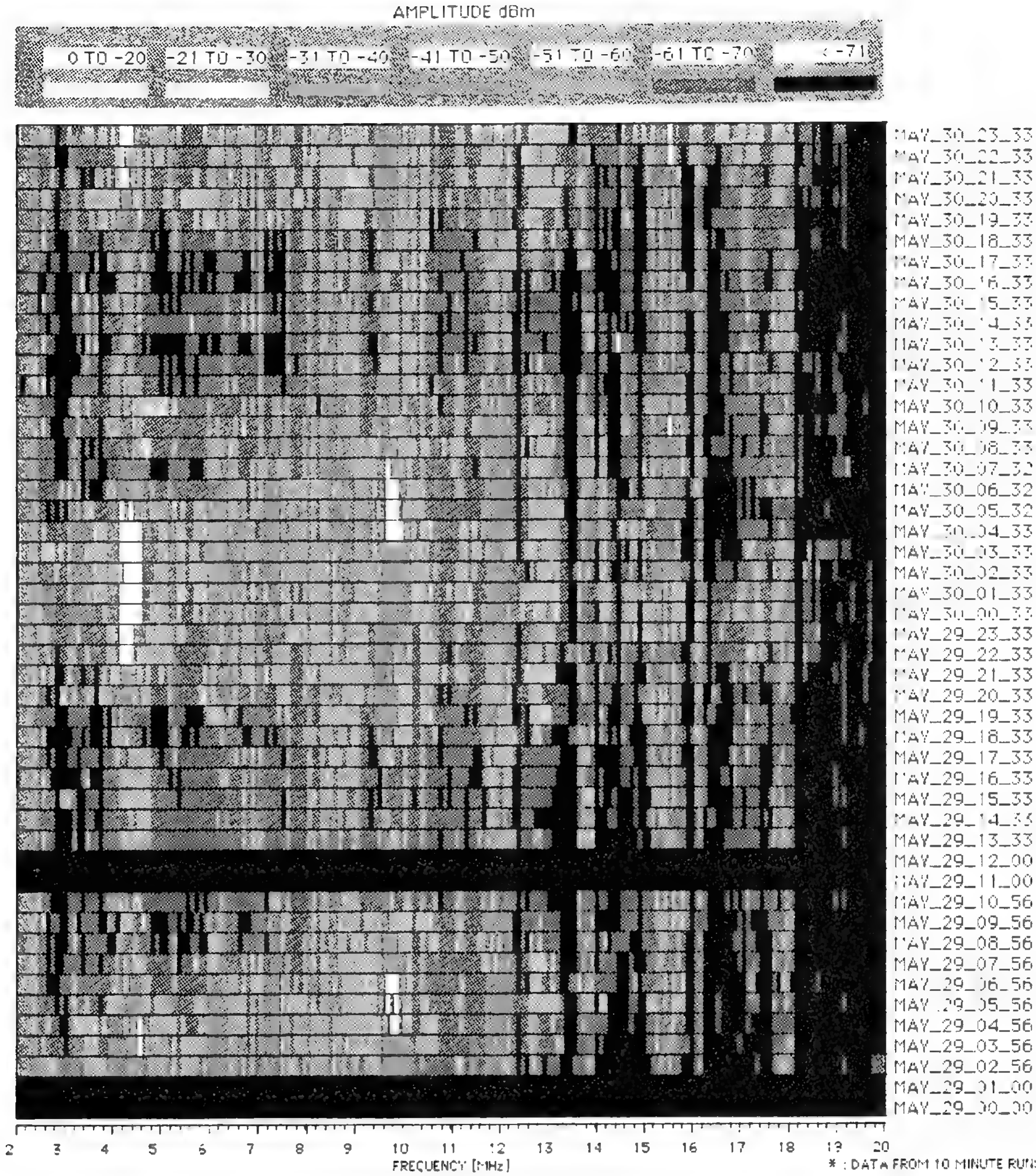
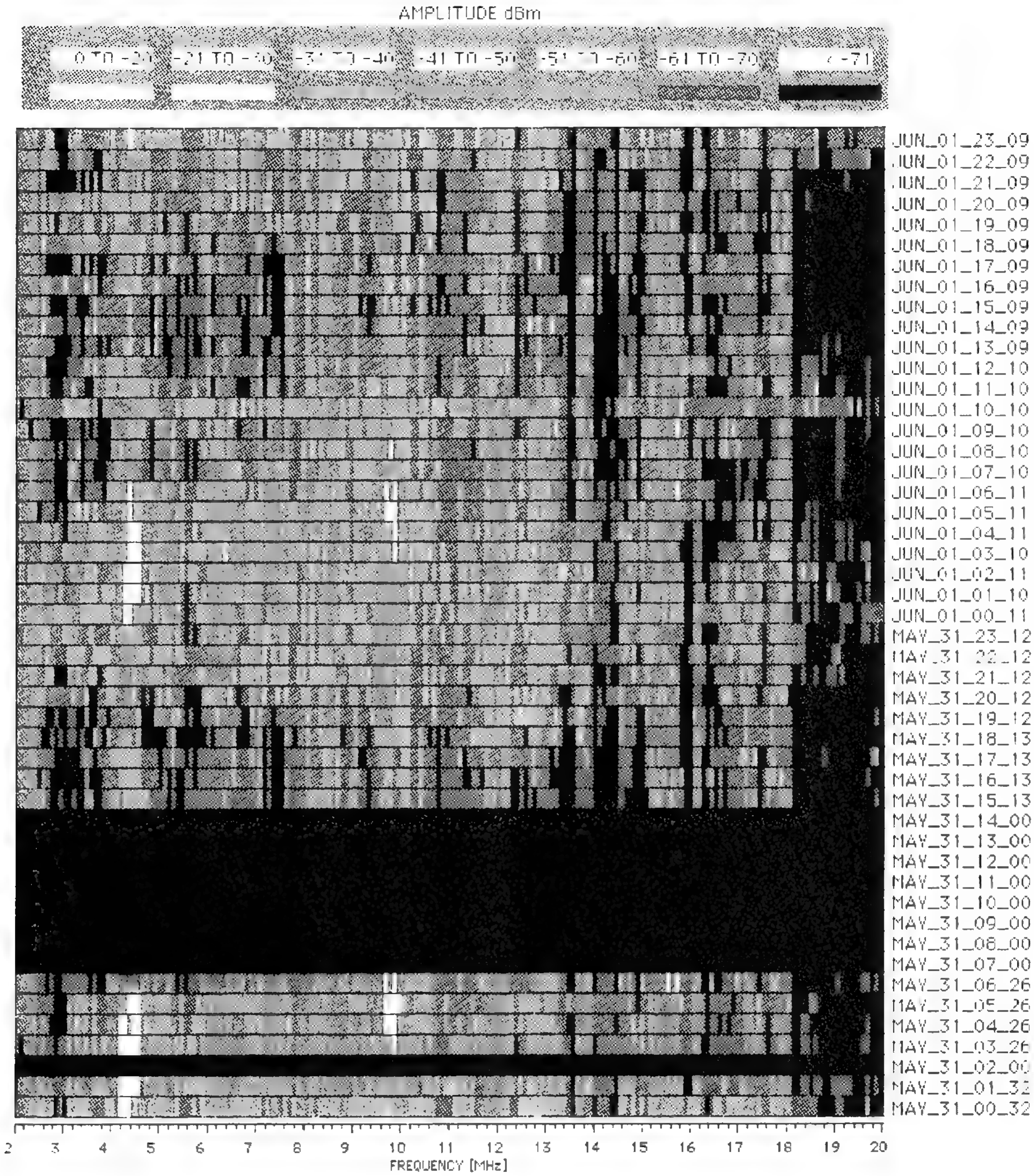

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
MAY_30_23_33
MAY_30_22_33
MAY_30_21_33
MAY_30_20_33
MAY_30_19_33
MAY_30_18_33
MAY_30_17_33
MAY_30_16_33
MAY_30_15_33
MAY_30_14_33
MAY_30_13_33
MAY_30_12_33
MAY_30_11_33
MAY_30_10_33
MAY_30_09_33
MAY_30_08_33
MAY_30_07_32
MAY_30_06_32
MAY_30_05_32
MAY_30_04_33
MAY_30_03_33
MAY_30_02_33
MAY_30_01_33
MAY_30_00_33
MAY_29_23_33
MAY_29_22_33
MAY_29_21_33
MAY_29_20_33
MAY_29_19_33
MAY_29_18_33
MAY_29_17_33
MAY_29_16_33
MAY_29_15_33
MAY_29_14_33
MAY_29_13_33
MAY_29_12_00
MAY_29_11_00
MAY_29_10_56
MAY_29_09_56
MAY_29_08_56
MAY_29_07_56
MAY_29_06_56
MAY_29_05_56
MAY_29_04_56
MAY_29_03_56
MAY_29_02_56
MAY_29_01_00
MAY_29_00_00
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
FREQUENCY (MHz)
* : DATA FROM 10 MINUTE RUNS

FIGURE 7



AMPLITUDE dBm
-41 TO -50
-61 TO -70
JUN_01_23_09
JUN_01_22_09
JUN_01_21_09
JUN_01_20_09
JUN_01_19_09
JUN_01_18_09
JUN_01_17_09
JUN_01_16_09
JUN_01_15_09
JUN_01_14_09
JUN_01_13_09
JUN_01_12_10
JUN_01_11_10
JUN_01_10_10
JUN_01_09_10
JUN_01_08_10
JUN_01_07_10
JUN_01_06_11
JUN_01_05_11
JUN_01_04_11
JUN_01_03_10
JUN_01_02_11
JUN_01_01_10
JUN_01_00_11
MAY_31_23_12
MAY_31_22_12
MAY_31_21_12
MAY_31_20_12
MAY_31_19_12
MAY_31_18_13
MAY_31_17_13
MAY_31_16_13
MAY_31_15_13
MAY_31_14_00
MAY_31_13_00
MAY_31_12_00
MAY_31_11_00
MAY_31_10_00
MAY_31_09_00
MAY_31_08_00
MAY_31_07_00
MAY_31_06_26
MAY_31_05_26
MAY_31_04_26
MAY_31_03_26
MAY_31_02_00
MAY_31_01_32
MAY_31_00_32
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
FREQUENCY [MHz]

FIGURE 8

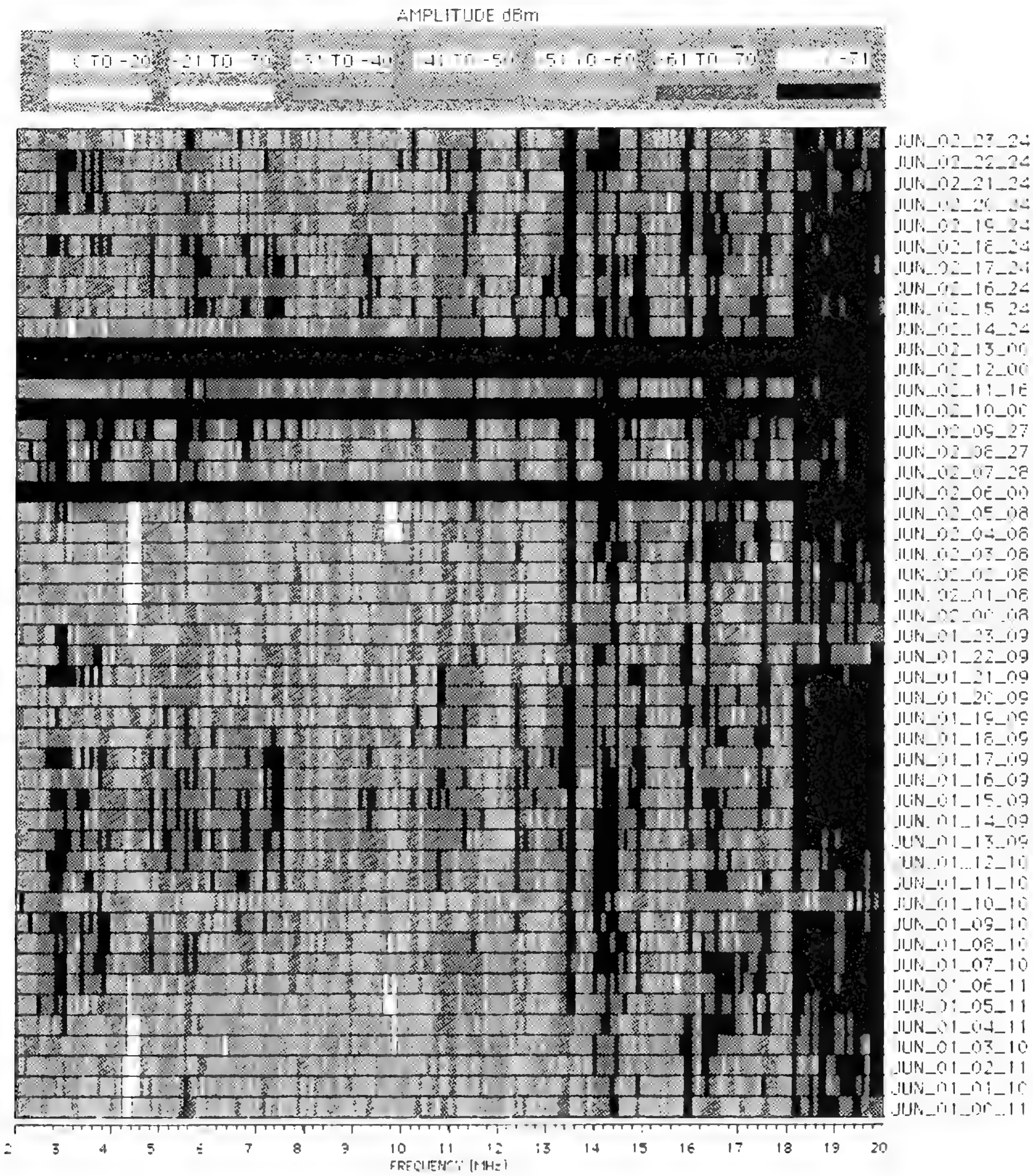

AMPLITUDE dBm
-61 TO -70
JUN_02_23_24
JUN_02_22_24
JUN_02_21_24
JUN_02_20_24
JUN_02_19_24
JUN_02_18_24
JUN_02_17_24
JUN_02_16_24
JUN_02_15_24
JUN_02_14_24
JUN_02_13_00
JUN_02_12_00
JUN_02_11_16
JUN_02_10_00
JUN_02_09_27
JUN_02_08_27
JUN_02_07_28
JUN_02_06_00
JUN_02_05_08
JUN_02_04_08
JUN_02_03_08
JUN_02_02_08
JUN_02_01_08
JUN_02_00_08
JUN_01_23_09
JUN_01_22_09
JUN_01_21_09
JUN_01_20_09
JUN_01_19_09
JUN_01_18_09
JUN_01_17_09
JUN_01_16_09
JUN_01_15_09
JUN_01_14_09
JUN_01_13_09
JUN_01_12_10
JUN_01_11_10
JUN_01_10_10
JUN_01_09_10
JUN_01_08_10
JUN_01_07_10
JUN_01_06_11
JUN_01_05_11
JUN_01_04_11
JUN_01_03_10
JUN_01_02_11
JUN_01_01_10
JUN_01_00_11
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
FREQUENCY (MHz)

FIGURE 9

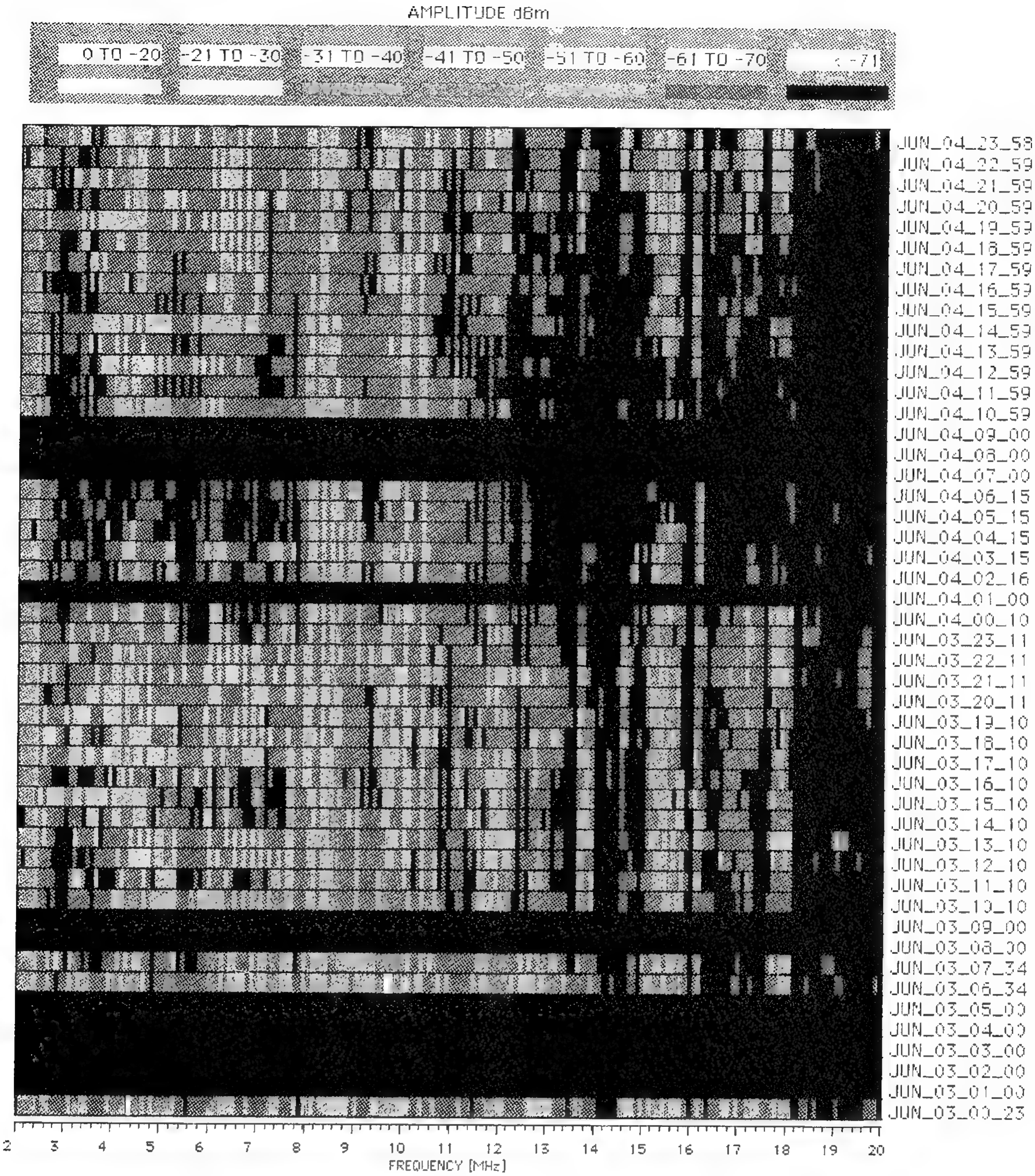

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
JUN_04_23_58
JUN_04_22_59
JUN_04_21_59
JUN_04_20_59
JUN_04_19_59
JUN_04_18_59
JUN_04_17_59
JUN_04_16_59
JUN_04_15_59
JUN_04_14_59
JUN_04_13_59
JUN_04_12_59
JUN_04_11_59
JUN_04_10_59
JUN_04_09_00
JUN_04_08_00
JUN_04_07_00
JUN_04_06_15
JUN_04_05_15
JUN_04_04_15
JUN_04_03_15
JUN_04_02_16
JUN_04_01_00
JUN_04_00_10
JUN_03_23_11
JUN_03_22_11
JUN_03_21_11
JUN_03_20_11
JUN_03_19_10
JUN_03_18_10
JUN_03_17_10
JUN_03_16_10
JUN_03_15_10
JUN_03_14_10
JUN_03_13_10
JUN_03_12_10
JUN_03_11_10
JUN_03_10_10
JUN_03_09_00
JUN_03_08_00
JUN_03_07_34
JUN_03_06_34
JUN_03_05_00
JUN_03_04_00
JUN_03_03_00
JUN_03_02_00
JUN_03_01_00
JUN_03_00_23
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
FREQUENCY [MHz]

FIGURE 10

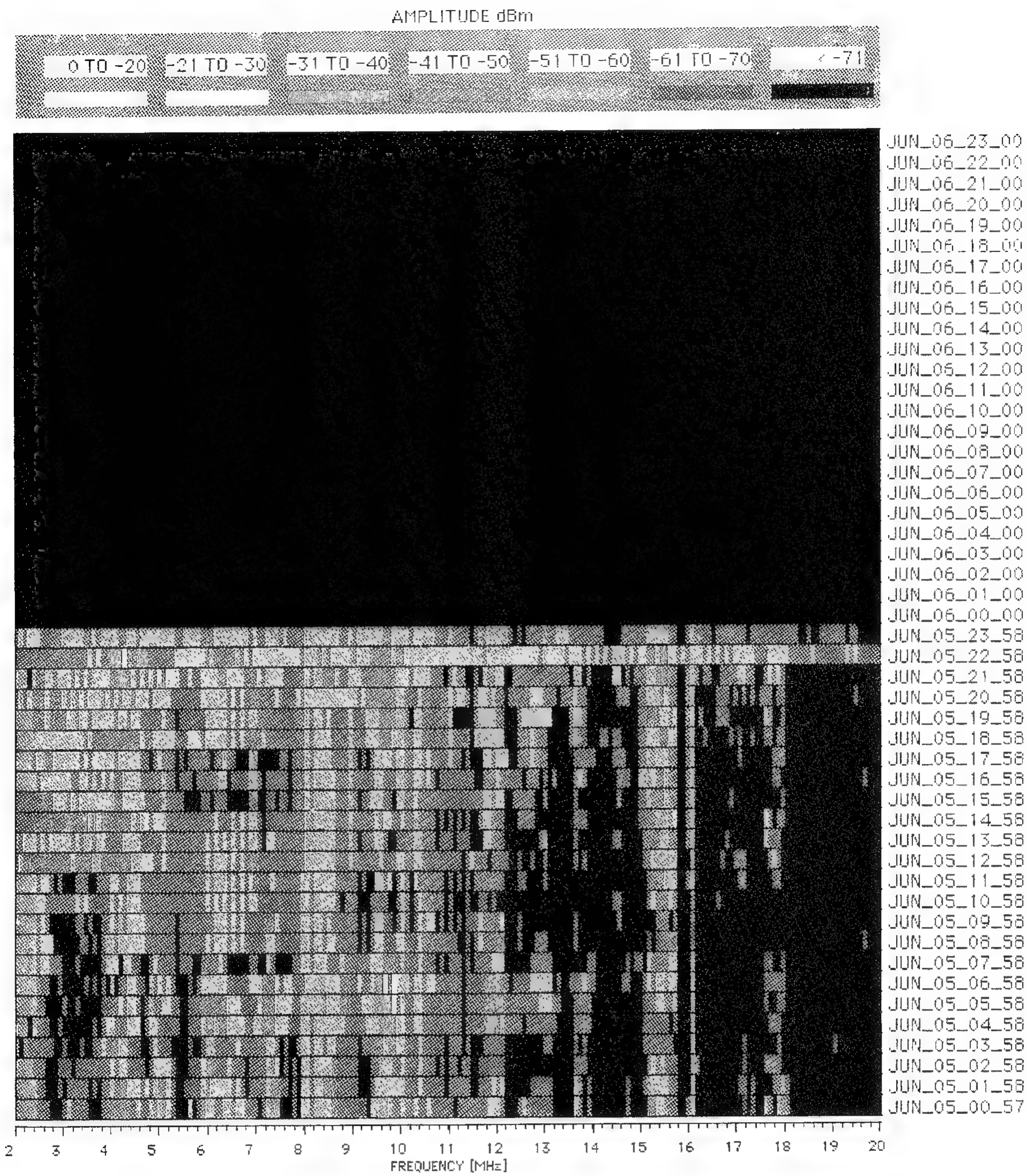

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
JUN_06_23_00
JUN_06_22_00
JUN_06_21_00
JUN_06_20_00
JUN_06_19_00
JUN_06_18_00
JUN_06_17_00
JUN_06_16_00
JUN_06_15_00
JUN_06_14_00
JUN_06_13_00
JUN_06_12_00
JUN_06_11_00
JUN_06_10_00
JUN_06_09_00
JUN_06_08_00
JUN_06_07_00
JUN_06_06_00
JUN_06_05_00
JUN_06_04_00
JUN_06_03_00
JUN_06_02_00
JUN_06_01_00
JUN_06_00_00
JUN_05_23_58
JUN_05_22_58
JUN_05_21_58
JUN_05_20_58
JUN_05_19_58
JUN_05_18_58
JUN_05_17_58
JUN_05_16_58
JUN_05_15_58
JUN_05_14_58
JUN_05_13_58
JUN_05_12_58
JUN_05_11_58
JUN_05_10_58
JUN_05_09_58
JUN_05_08_58
JUN_05_07_58
JUN_05_06_58
JUN_05_05_58
JUN_05_04_58
JUN_05_03_58
JUN_05_02_58
JUN_05_01_58
JUN_05_00_57
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
FREQUENCY [MHz]

FIGURE 11

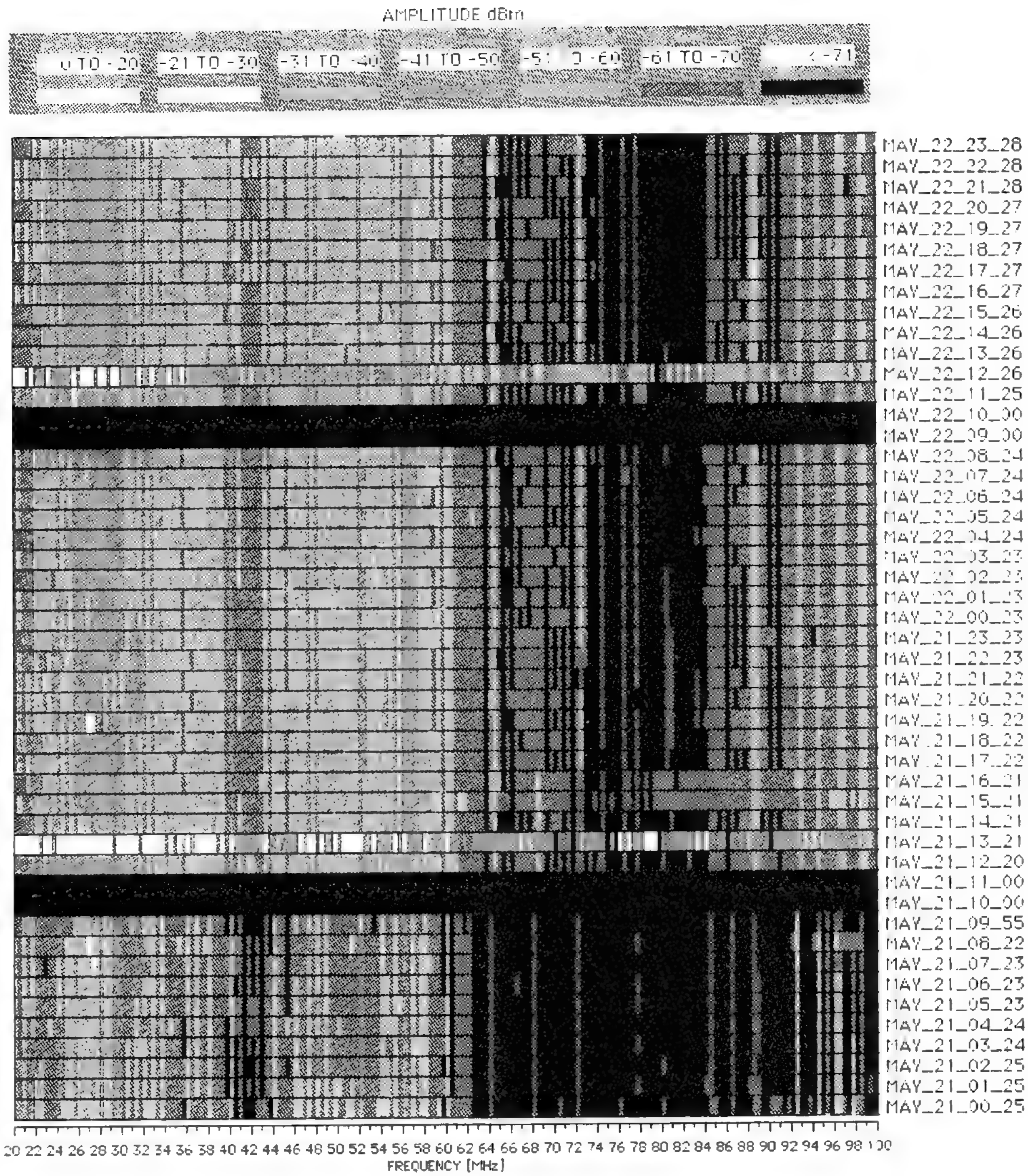

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-61 TO -70
MAY_22_23_28
MAY_22_22_28
MAY_22_21_28
MAY_22_20_27
MAY_22_19_27
MAY_22_18_27
MAY_22_17_27
MAY_22_16_27
MAY_22_15_26
MAY_22_14_26
MAY_22_13_26
MAY_22_12_26
MAY_22_11_25
MAY_22_10_00
MAY_22_09_00
MAY_22_08_24
MAY_22_07_24
MAY_22_06_24
MAY_22_05_24
MAY_22_04_24
MAY_22_03_23
MAY_22_02_23
MAY_22_01_23
MAY_22_00_23
MAY_21_23_23
MAY_21_22_23
MAY_21_21_22
MAY_21_20_22
MAY_21_19_22
MAY_21_18_22
MAY_21_17_22
MAY_21_16_21
MAY_21_15_21
MAY_21_14_21
MAY_21_13_21
MAY_21_12_20
MAY_21_11_00
MAY_21_10_00
MAY_21_09_55
MAY_21_08_22
MAY_21_07_23
MAY_21_06_23
MAY_21_05_23
MAY_21_04_24
MAY_21_03_24
MAY_21_02_25
MAY_21_01_25
MAY_21_00_25
20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100
FREQUENCY (MHz)

FIGURE 12

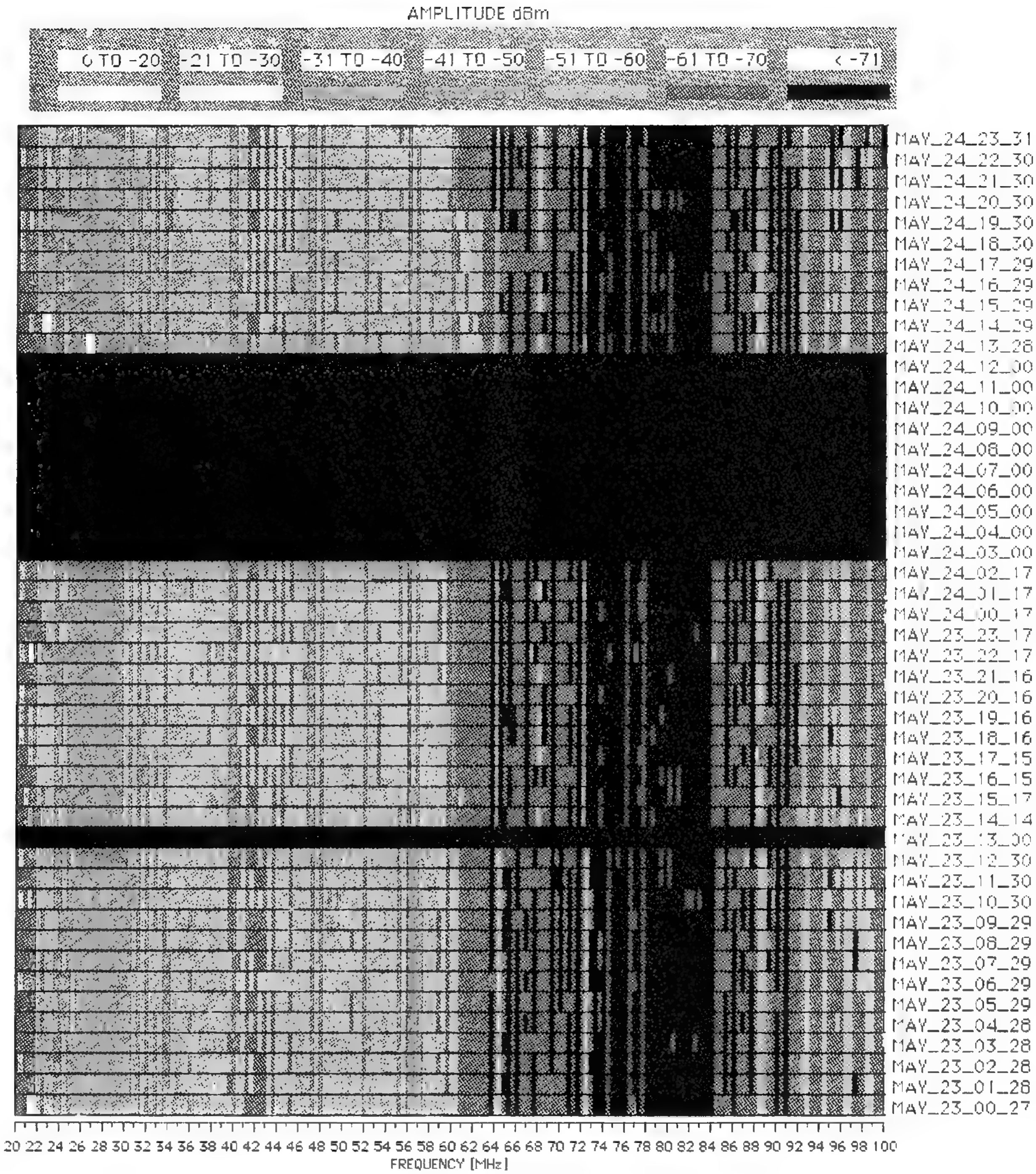

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
MAY_24_23_31
MAY_24_22_30
MAY_24_21_30
MAY_24_20_30
MAY_24_19_30
MAY_24_18_30
MAY_24_17_29
MAY_24_16_29
MAY_24_15_29
MAY_24_14_29
MAY_24_13_28
MAY_24_12_00
MAY_24_11_00
MAY_24_10_00
MAY_24_09_00
MAY_24_08_00
MAY_24_07_00
MAY_24_06_00
MAY_24_05_00
MAY_24_04_00
MAY_24_03_00
MAY_24_02_17
MAY_24_01_17
MAY_24_00_17
MAY_23_23_17
MAY_23_22_17
MAY_23_21_16
MAY_23_20_16
MAY_23_19_16
MAY_23_18_16
MAY_23_17_15
MAY_23_16_15
MAY_23_15_17
MAY_23_14_14
MAY_23_13_00
MAY_23_12_30
MAY_23_11_30
MAY_23_10_30
MAY_23_09_29
MAY_23_08_29
MAY_23_07_29
MAY_23_06_29
MAY_23_05_29
MAY_23_04_28
MAY_23_03_28
MAY_23_02_28
MAY_23_01_28
MAY_23_00_27
20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100
FREQUENCY [MHz]

FIGURE 13

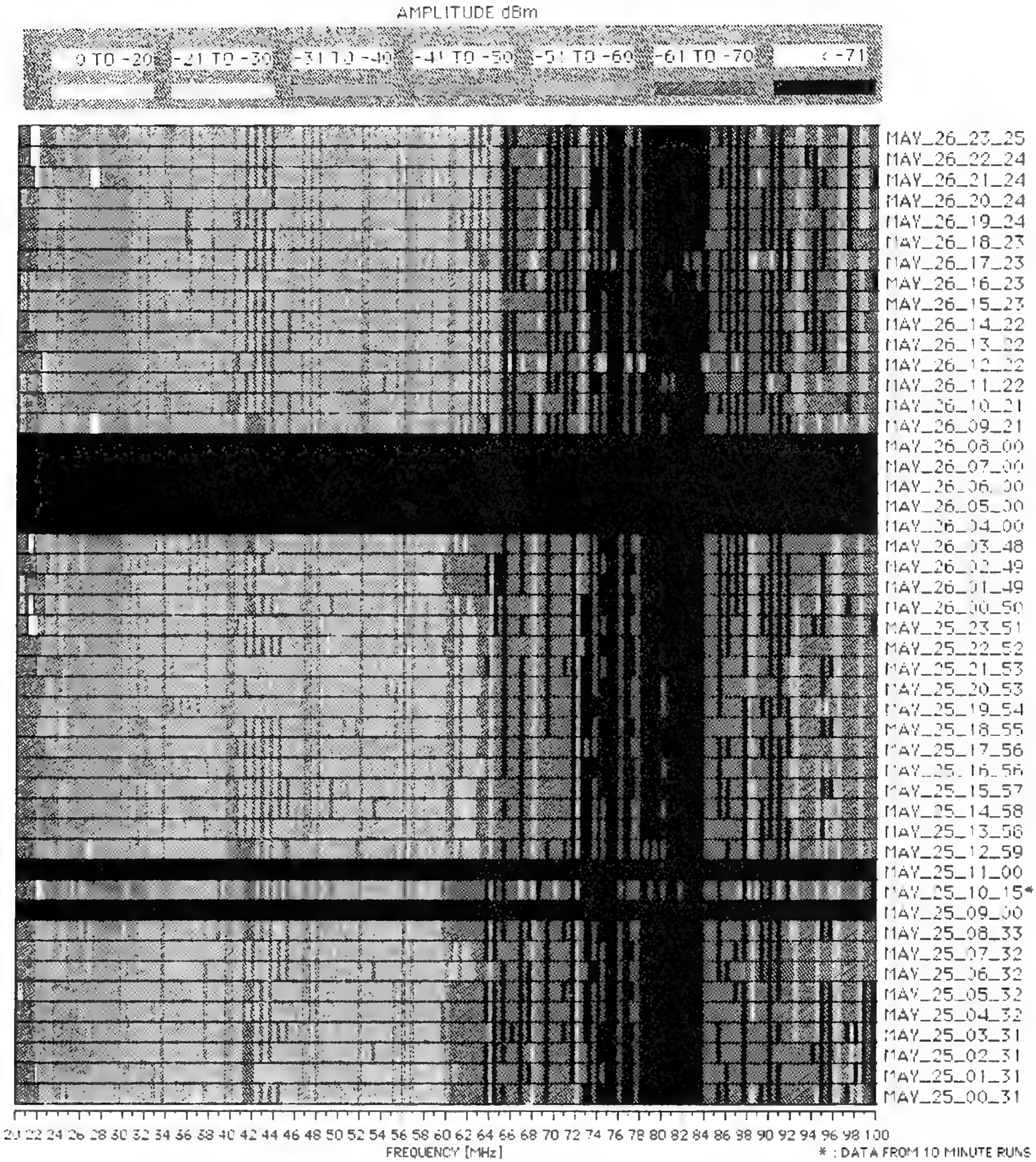

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
MAY_26_23_25
MAY_26_22_24
MAY_26_21_24
MAY_26_20_24
MAY_26_19_24
MAY_26_18_23
MAY_26_17_23
MAY_26_16_23
MAY_26_15_23
MAY_26_14_22
MAY_26_13_22
MAY_26_12_22
MAY_26_11_22
MAY_26_10_21
MAY_26_09_21
MAY_26_08_00
MAY_26_07_00
MAY_26_06_00
MAY_26_05_00
MAY_26_04_00
MAY_26_03_48
MAY_26_02_49
MAY_26_01_49
MAY_26_00_50
MAY_25_23_51
MAY_25_22_52
MAY_25_21_53
MAY_25_20_53
MAY_25_19_54
MAY_25_18_55
MAY_25_17_56
MAY_25_16_56
MAY_25_15_57
MAY_25_14_58
MAY_25_13_58
MAY_25_12_59
MAY_25_11_00
MAY_25_10_15*
MAY_25_09_00
MAY_25_08_33
MAY_25_07_32
MAY_25_06_32
MAY_25_05_32
MAY_25_04_32
MAY_25_03_31
MAY_25_02_31
MAY_25_01_31
MAY_25_00_31
20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100
FREQUENCY [MHz]
* : DATA FROM 10 MINUTE RUNS

FIGURE 14

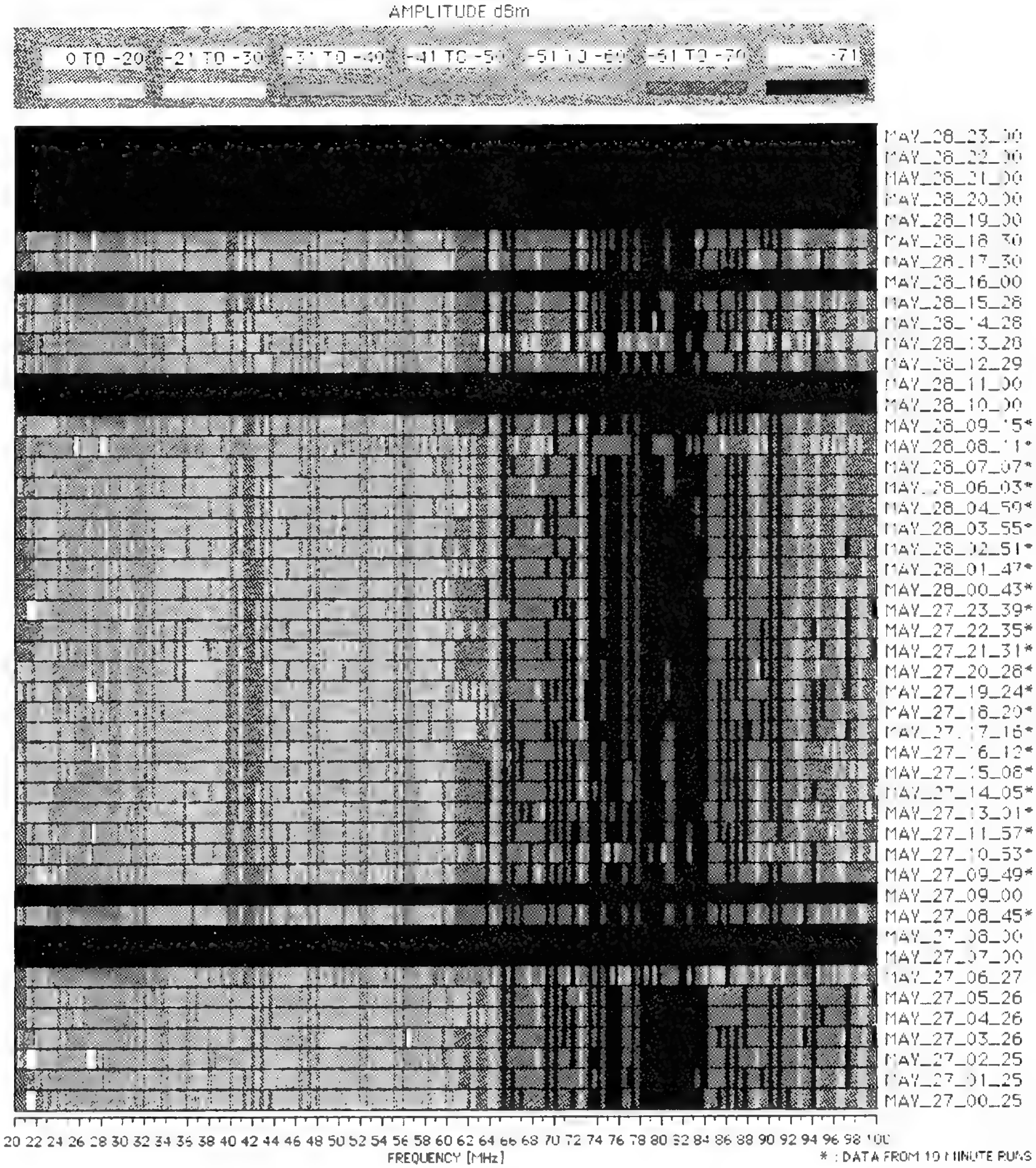
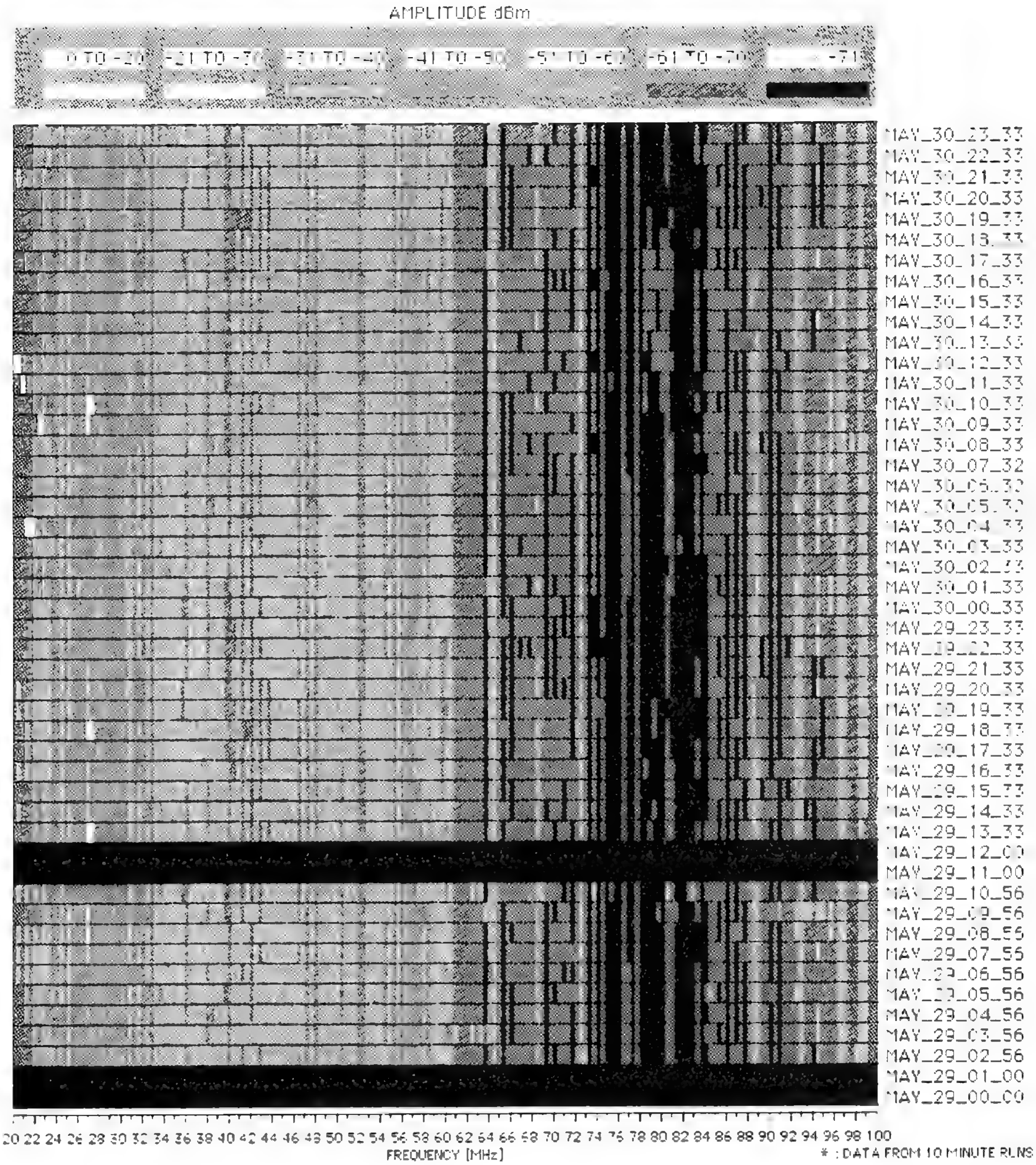

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
-71
FREQUENCY [MHz]
* : DATA FROM 10 MINUTE RUNS

FIGURE 15



AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
-71
MAY_30_23_33
MAY_30_22_33
MAY_30_21_33
MAY_30_20_33
MAY_30_19_33
MAY_30_18_33
MAY_30_17_33
MAY_30_16_33
MAY_30_15_33
MAY_30_14_33
MAY_30_13_33
MAY_30_12_33
MAY_30_11_33
MAY_30_10_33
MAY_30_09_33
MAY_30_08_33
MAY_30_07_32
MAY_30_06_32
MAY_30_05_32
MAY_30_04_33
MAY_30_03_33
MAY_30_02_33
MAY_30_01_33
MAY_30_00_33
MAY_29_23_33
MAY_29_22_33
MAY_29_21_33
MAY_29_20_33
MAY_29_19_33
MAY_29_18_33
MAY_29_17_33
MAY_29_16_33
MAY_29_15_33
MAY_29_14_33
MAY_29_13_33
MAY_29_12_00
MAY_29_11_00
MAY_29_10_56
MAY_29_09_56
MAY_29_08_56
MAY_29_07_56
MAY_29_06_56
MAY_29_05_56
MAY_29_04_56
MAY_29_03_56
MAY_29_02_56
MAY_29_01_00
MAY_29_00_00
20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100
FREQUENCY [MHz]
* : DATA FROM 10 MINUTE RUNS

FIGURE 16

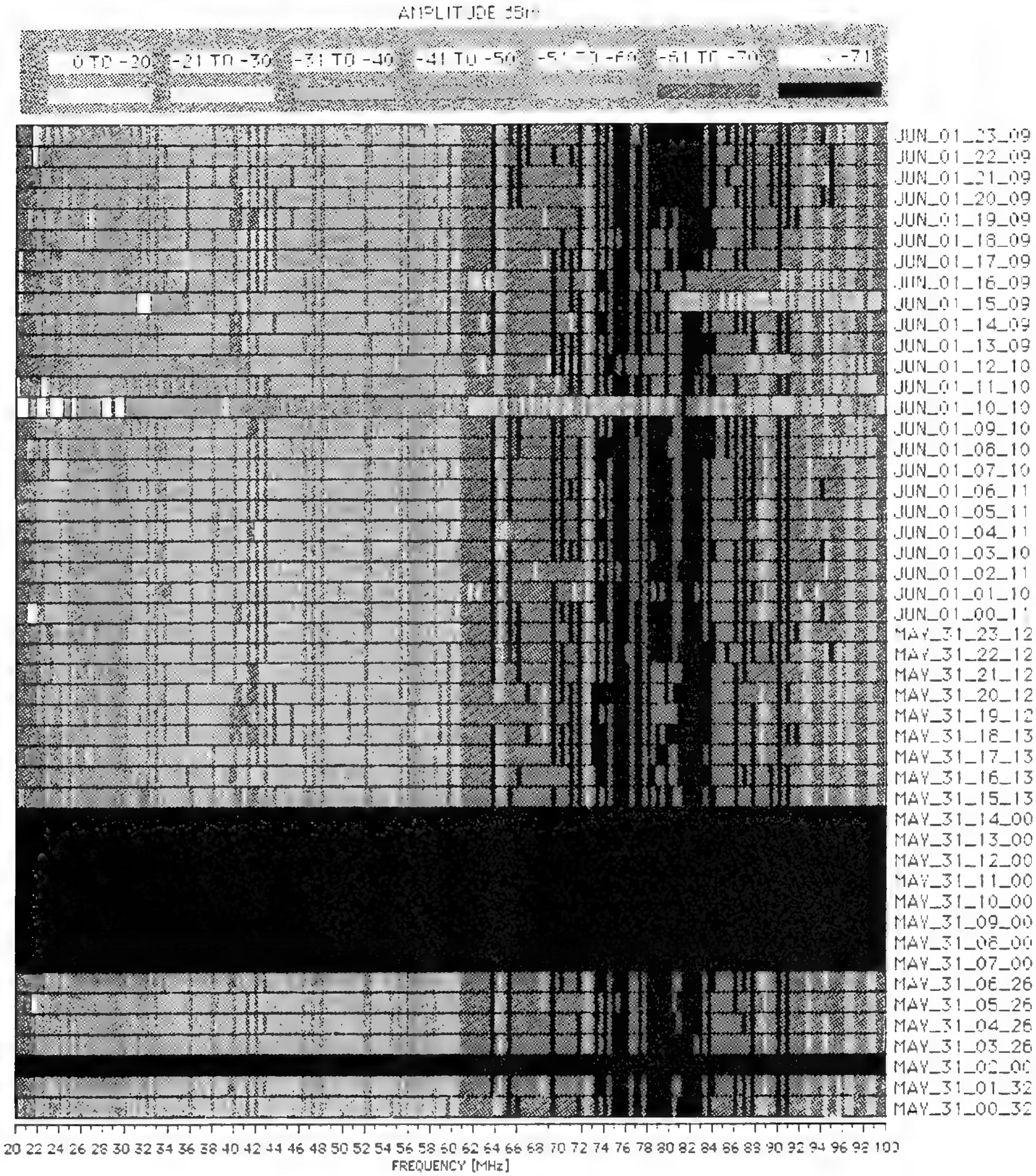

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-61 TO -70
JUN_01_23_09
JUN_01_22_09
JUN_01_21_09
JUN_01_20_09
JUN_01_19_09
JUN_01_18_09
JUN_01_17_09
JUN_01_16_09
JUN_01_15_09
JUN_01_14_09
JUN_01_13_09
JUN_01_12_10
JUN_01_11_10
JUN_01_10_10
JUN_01_09_10
JUN_01_08_10
JUN_01_07_10
JUN_01_06_11
JUN_01_05_11
JUN_01_04_11
JUN_01_03_10
JUN_01_02_11
JUN_01_01_10
JUN_01_00_11
MAY_31_23_12
MAY_31_22_12
MAY_31_21_12
MAY_31_20_12
MAY_31_19_12
MAY_31_18_13
MAY_31_17_13
MAY_31_16_13
MAY_31_15_13
MAY_31_14_00
MAY_31_13_00
MAY_31_12_00
MAY_31_11_00
MAY_31_10_00
MAY_31_09_00
MAY_31_08_00
MAY_31_07_00
MAY_31_06_26
MAY_31_05_26
MAY_31_04_26
MAY_31_03_26
MAY_31_02_00
MAY_31_01_32
MAY_31_00_32
20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100
FREQUENCY (MHz)

FIGURE 17

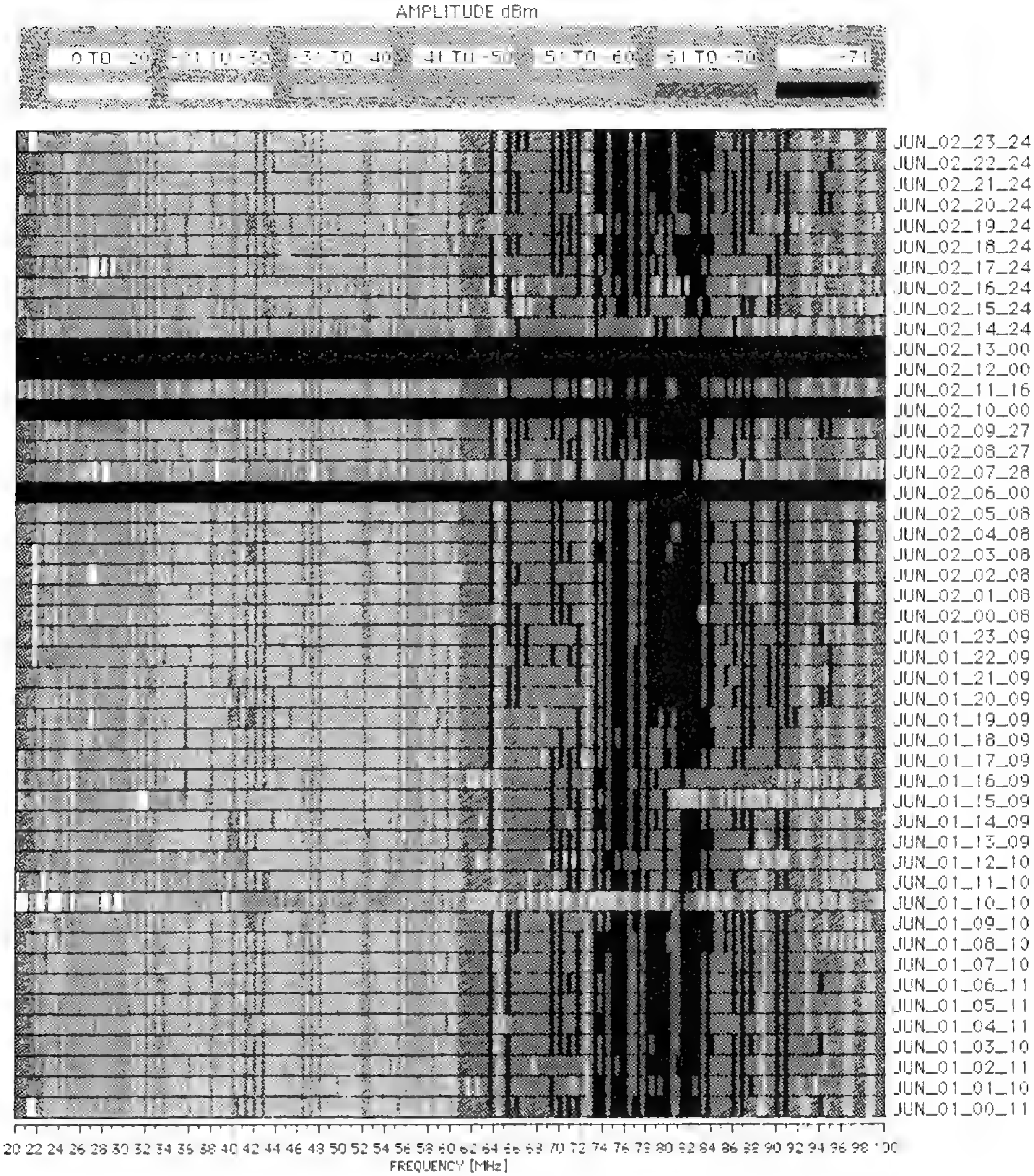

AMPLITUDE dBm
0 TO -20
-41 TO -50
-71
JUN_02_23_24
JUN_02_22_24
JUN_02_21_24
JUN_02_20_24
JUN_02_19_24
JUN_02_18_24
JUN_02_17_24
JUN_02_16_24
JUN_02_15_24
JUN_02_14_24
JUN_02_13_00
JUN_02_12_00
JUN_02_11_16
JUN_02_10_00
JUN_02_09_27
JUN_02_08_27
JUN_02_07_28
JUN_02_06_00
JUN_02_05_08
JUN_02_04_08
JUN_02_03_08
JUN_02_02_08
JUN_02_01_08
JUN_02_00_08
JUN_01_23_09
JUN_01_22_09
JUN_01_21_09
JUN_01_20_09
JUN_01_19_09
JUN_01_18_09
JUN_01_17_09
JUN_01_16_09
JUN_01_15_09
JUN_01_14_09
JUN_01_13_09
JUN_01_12_10
JUN_01_11_10
JUN_01_10_10
JUN_01_09_10
JUN_01_08_10
JUN_01_07_10
JUN_01_06_11
JUN_01_05_11
JUN_01_04_11
JUN_01_03_10
JUN_01_02_11
JUN_01_01_10
JUN_01_00_11
20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100
FREQUENCY [MHz]

FIGURE 18

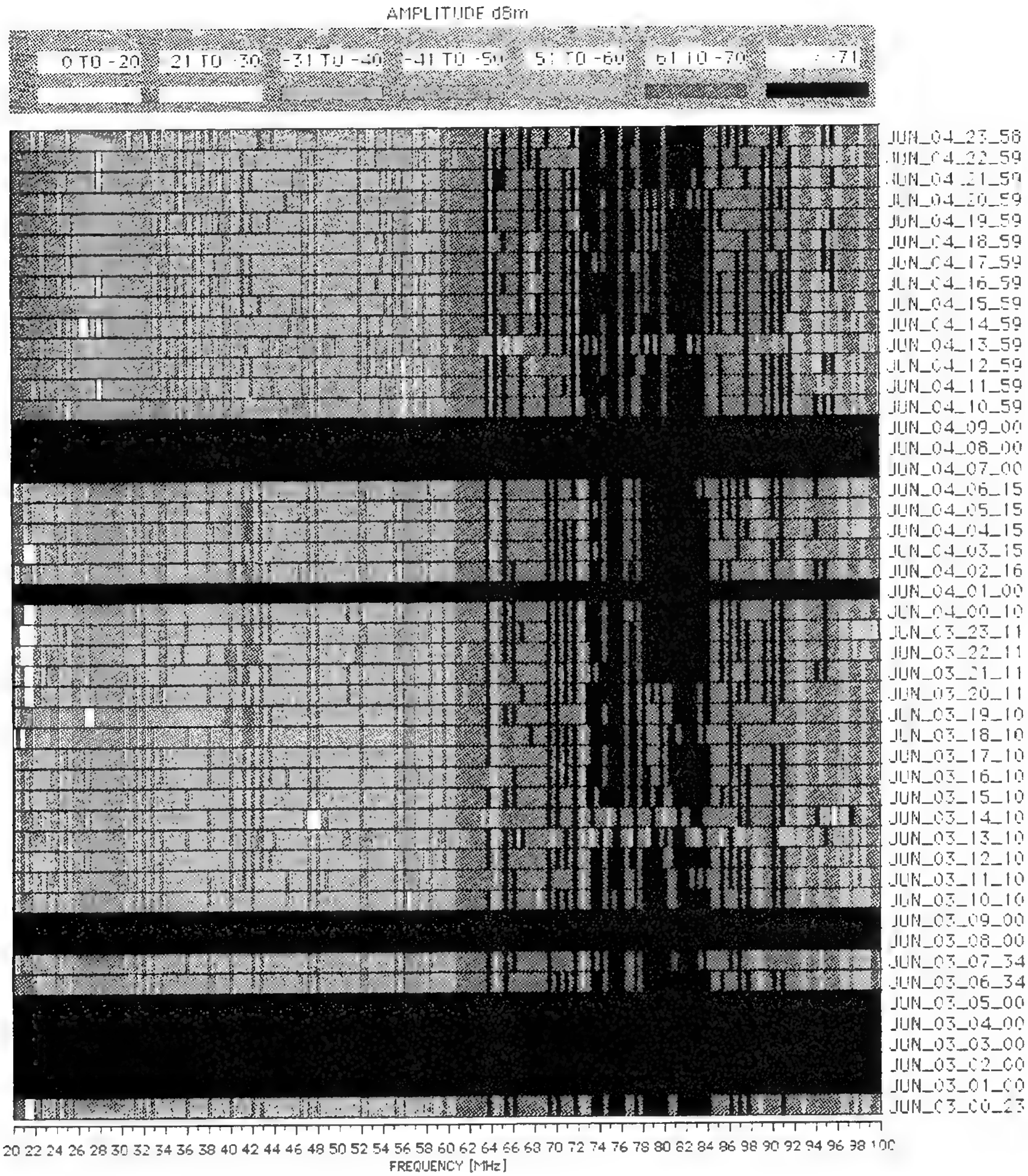

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
JUN_04_23_58
JUN_04_22_59
JUN_04_21_59
JUN_04_20_59
JUN_04_19_59
JUN_04_18_59
JUN_04_17_59
JUN_04_16_59
JUN_04_15_59
JUN_04_14_59
JUN_04_13_59
JUN_04_12_59
JUN_04_11_59
JUN_04_10_59
JUN_04_09_00
JUN_04_08_00
JUN_04_07_00
JUN_04_06_15
JUN_04_05_15
JUN_04_04_15
JUN_04_03_15
JUN_04_02_16
JUN_04_01_00
JUN_04_00_10
JUN_03_23_11
JUN_03_22_11
JUN_03_21_11
JUN_03_20_11
JUN_03_19_10
JUN_03_18_10
JUN_03_17_10
JUN_03_16_10
JUN_03_15_10
JUN_03_14_10
JUN_03_13_10
JUN_03_12_10
JUN_03_11_10
JUN_03_10_10
JUN_03_09_00
JUN_03_08_00
JUN_03_07_34
JUN_03_06_34
JUN_03_05_00
JUN_03_04_00
JUN_03_03_00
JUN_03_02_00
JUN_03_01_00
JUN_03_00_23
20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100
FREQUENCY [MHz]

FIGURE 19

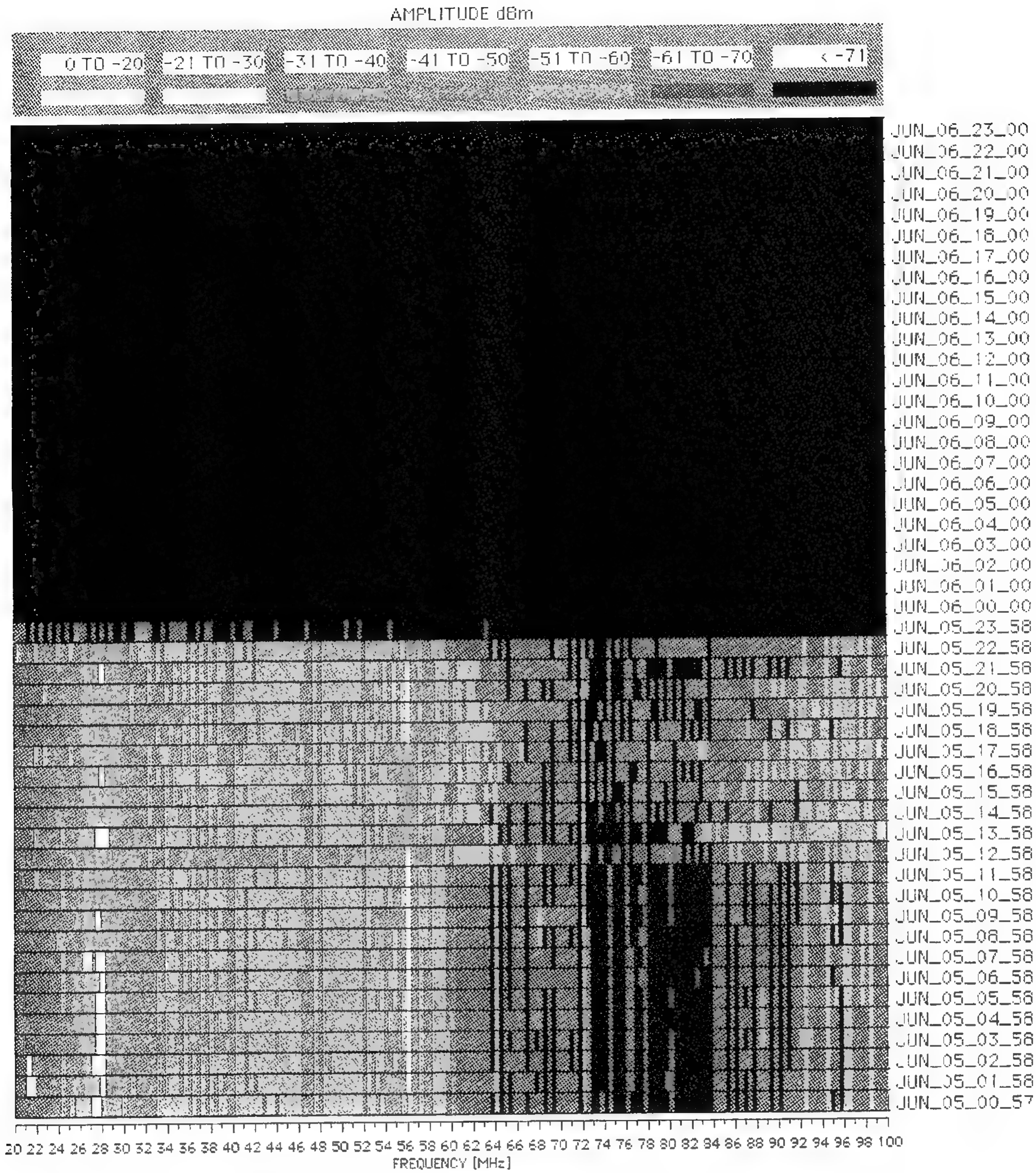

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
JUN_06_23_00
JUN_06_22_00
JUN_06_21_00
JUN_06_20_00
JUN_06_19_00
JUN_06_18_00
JUN_06_17_00
JUN_06_16_00
JUN_06_15_00
JUN_06_14_00
JUN_06_13_00
JUN_06_12_00
JUN_06_11_00
JUN_06_10_00
JUN_06_09_00
JUN_06_08_00
JUN_06_07_00
JUN_06_06_00
JUN_06_05_00
JUN_06_04_00
JUN_06_03_00
JUN_06_02_00
JUN_06_01_00
JUN_06_00_00
JUN_05_23_58
JUN_05_22_58
JUN_05_21_58
JUN_05_20_58
JUN_05_19_58
JUN_05_18_58
JUN_05_17_58
JUN_05_16_58
JUN_05_15_58
JUN_05_14_58
JUN_05_13_58
JUN_05_12_58
JUN_05_11_58
JUN_05_10_58
JUN_05_09_58
JUN_05_08_58
JUN_05_07_58
JUN_05_06_58
JUN_05_05_58
JUN_05_04_58
JUN_05_03_58
JUN_05_02_58
JUN_05_01_58
JUN_05_00_57
20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100
FREQUENCY [MHz]

FIGURE 20

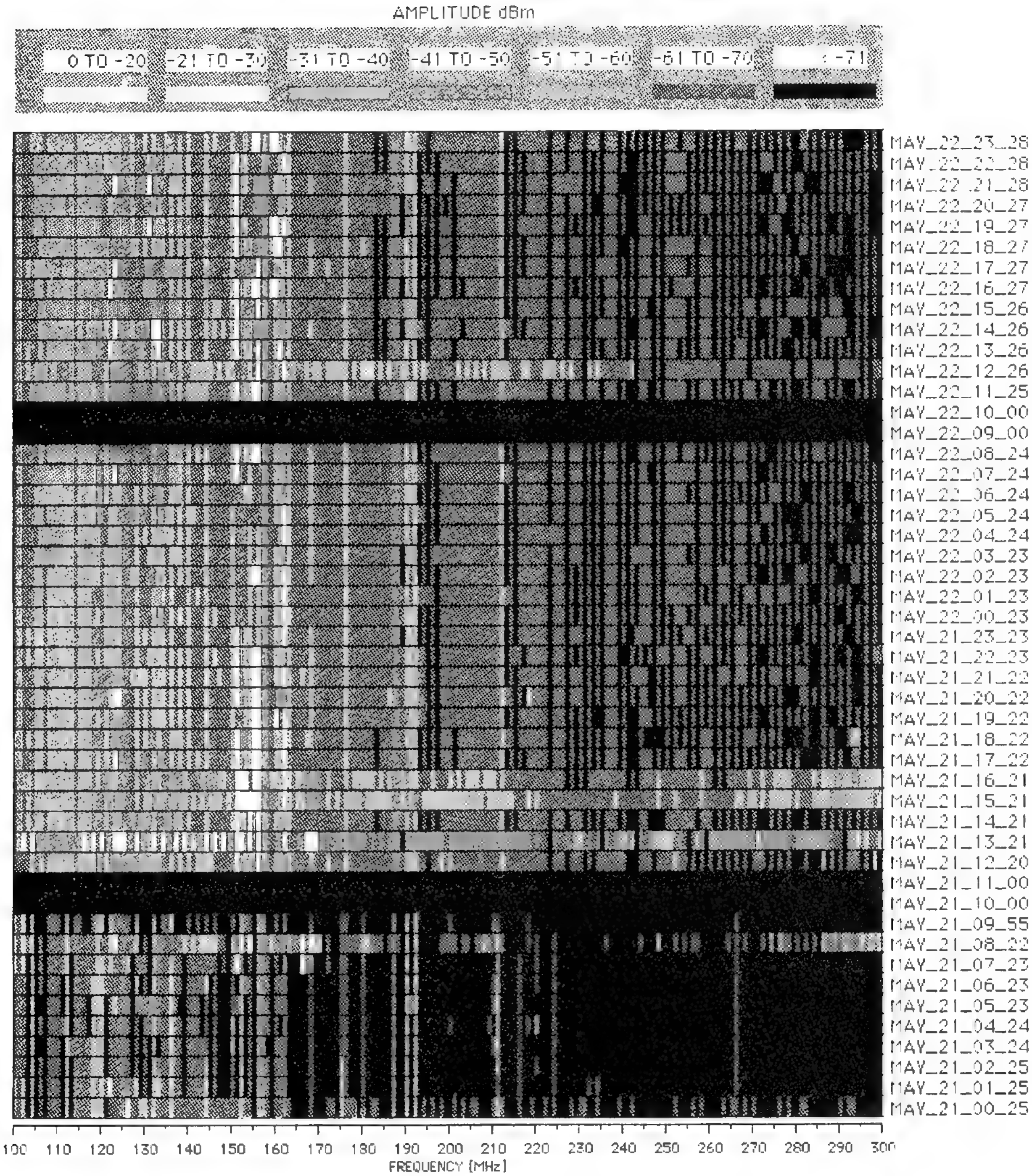

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
MAY_22_23_28
MAY_22_22_28
MAY_22_21_28
MAY_22_20_27
MAY_22_19_27
MAY_22_18_27
MAY_22_17_27
MAY_22_16_27
MAY_22_15_26
MAY_22_14_26
MAY_22_13_26
MAY_22_12_26
MAY_22_11_25
MAY_22_10_00
MAY_22_09_00
MAY_22_08_24
MAY_22_07_24
MAY_22_06_24
MAY_22_05_24
MAY_22_04_24
MAY_22_03_23
MAY_22_02_23
MAY_22_01_23
MAY_22_00_23
MAY_21_23_23
MAY_21_22_23
MAY_21_21_22
MAY_21_20_22
MAY_21_19_22
MAY_21_18_22
MAY_21_17_22
MAY_21_16_21
MAY_21_15_21
MAY_21_14_21
MAY_21_13_21
MAY_21_12_20
MAY_21_11_00
MAY_21_10_00
MAY_21_09_55
MAY_21_08_22
MAY_21_07_23
MAY_21_06_23
MAY_21_05_23
MAY_21_04_24
MAY_21_03_24
MAY_21_02_25
MAY_21_01_25
MAY_21_00_25
100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300
FREQUENCY (MHz)

FIGURE 21

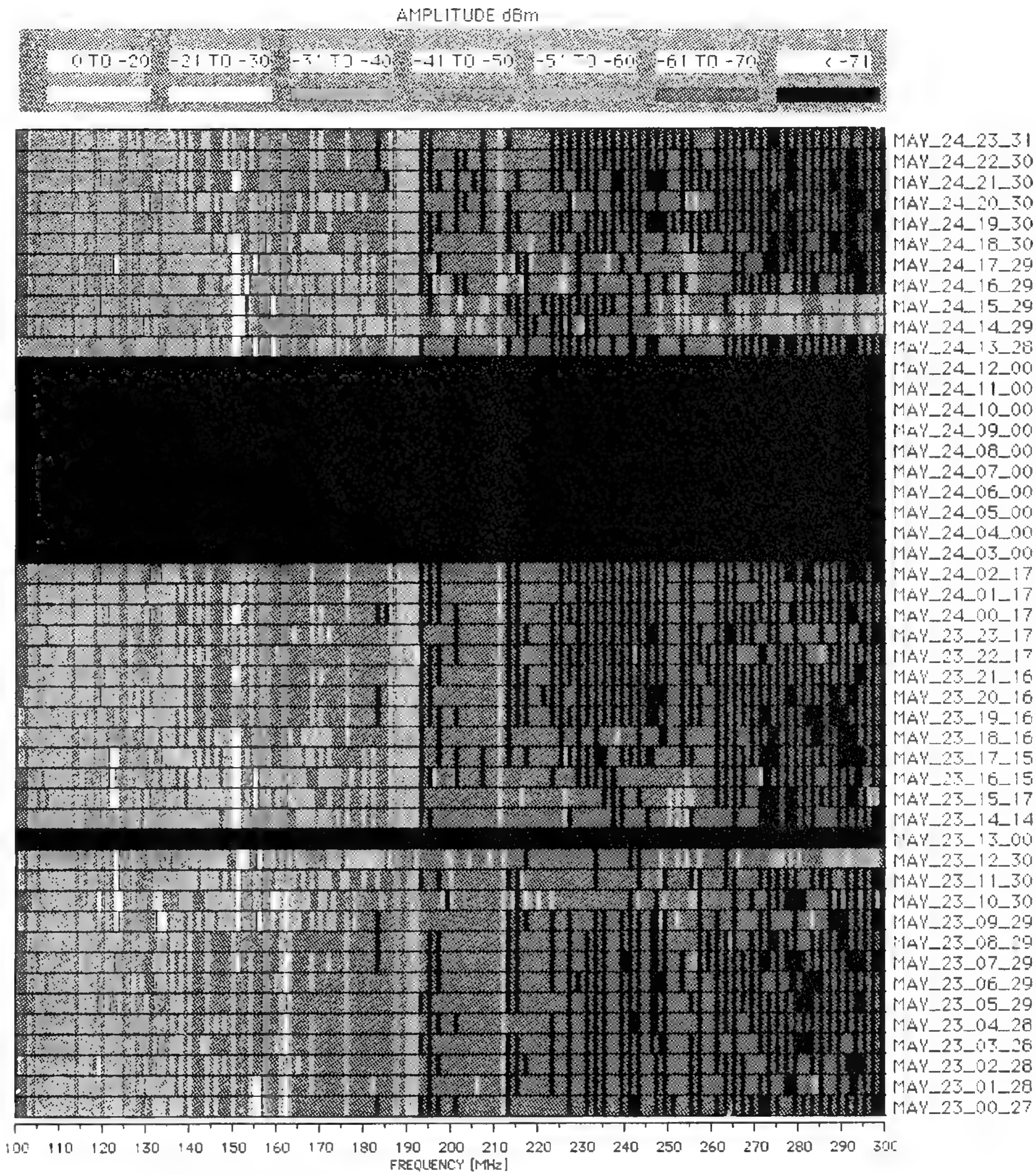

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
MAY_24_23_31
MAY_24_22_30
MAY_24_21_30
MAY_24_20_30
MAY_24_19_30
MAY_24_18_30
MAY_24_17_29
MAY_24_16_29
MAY_24_15_29
MAY_24_14_29
MAY_24_13_28
MAY_24_12_00
MAY_24_11_00
MAY_24_10_00
MAY_24_09_00
MAY_24_08_00
MAY_24_07_00
MAY_24_06_00
MAY_24_05_00
MAY_24_04_00
MAY_24_03_00
MAY_24_02_17
MAY_24_01_17
MAY_24_00_17
MAY_23_23_17
MAY_23_22_17
MAY_23_21_16
MAY_23_20_16
MAY_23_19_16
MAY_23_18_16
MAY_23_17_15
MAY_23_16_15
MAY_23_15_17
MAY_23_14_14
MAY_23_13_00
MAY_23_12_30
MAY_23_11_30
MAY_23_10_30
MAY_23_09_29
MAY_23_08_29
MAY_23_07_29
MAY_23_06_29
MAY_23_05_29
MAY_23_04_28
MAY_23_03_28
MAY_23_02_28
MAY_23_01_28
MAY_23_00_27
100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300
FREQUENCY [MHz]

FIGURE 22

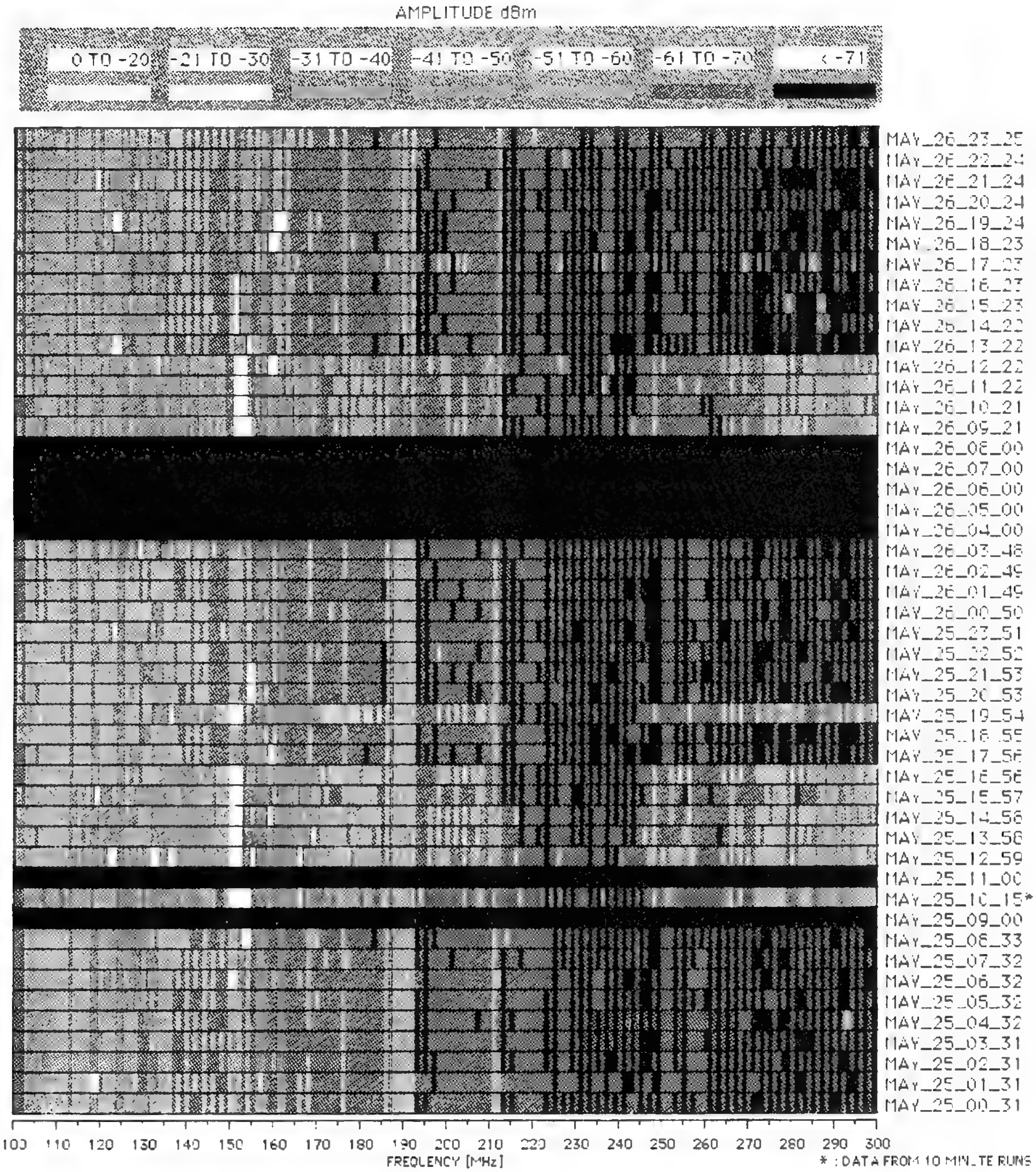

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
MAY_26_23_25
MAY_26_22_24
MAY_26_21_24
MAY_26_20_24
MAY_26_19_24
MAY_26_18_23
MAY_26_17_23
MAY_26_16_23
MAY_26_15_23
MAY_26_14_22
MAY_26_13_22
MAY_26_12_22
MAY_26_11_22
MAY_26_10_21
MAY_26_09_21
MAY_26_08_00
MAY_26_07_00
MAY_26_06_00
MAY_26_05_00
MAY_26_04_00
MAY_26_03_48
MAY_26_02_49
MAY_26_01_49
MAY_26_00_50
MAY_25_23_51
MAY_25_22_52
MAY_25_21_53
MAY_25_20_53
MAY_25_19_54
MAY_25_18_55
MAY_25_17_56
MAY_25_16_56
MAY_25_15_57
MAY_25_14_58
MAY_25_13_58
MAY_25_12_59
MAY_25_11_00
MAY_25_10_15*
MAY_25_09_00
MAY_25_08_33
MAY_25_07_32
MAY_25_06_32
MAY_25_05_32
MAY_25_04_32
MAY_25_03_31
MAY_25_02_31
MAY_25_01_31
MAY_25_00_31
100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300
FREQUENCY [MHz]
* : DATA FROM 10 MINUTE RUNS

FIGURE 23

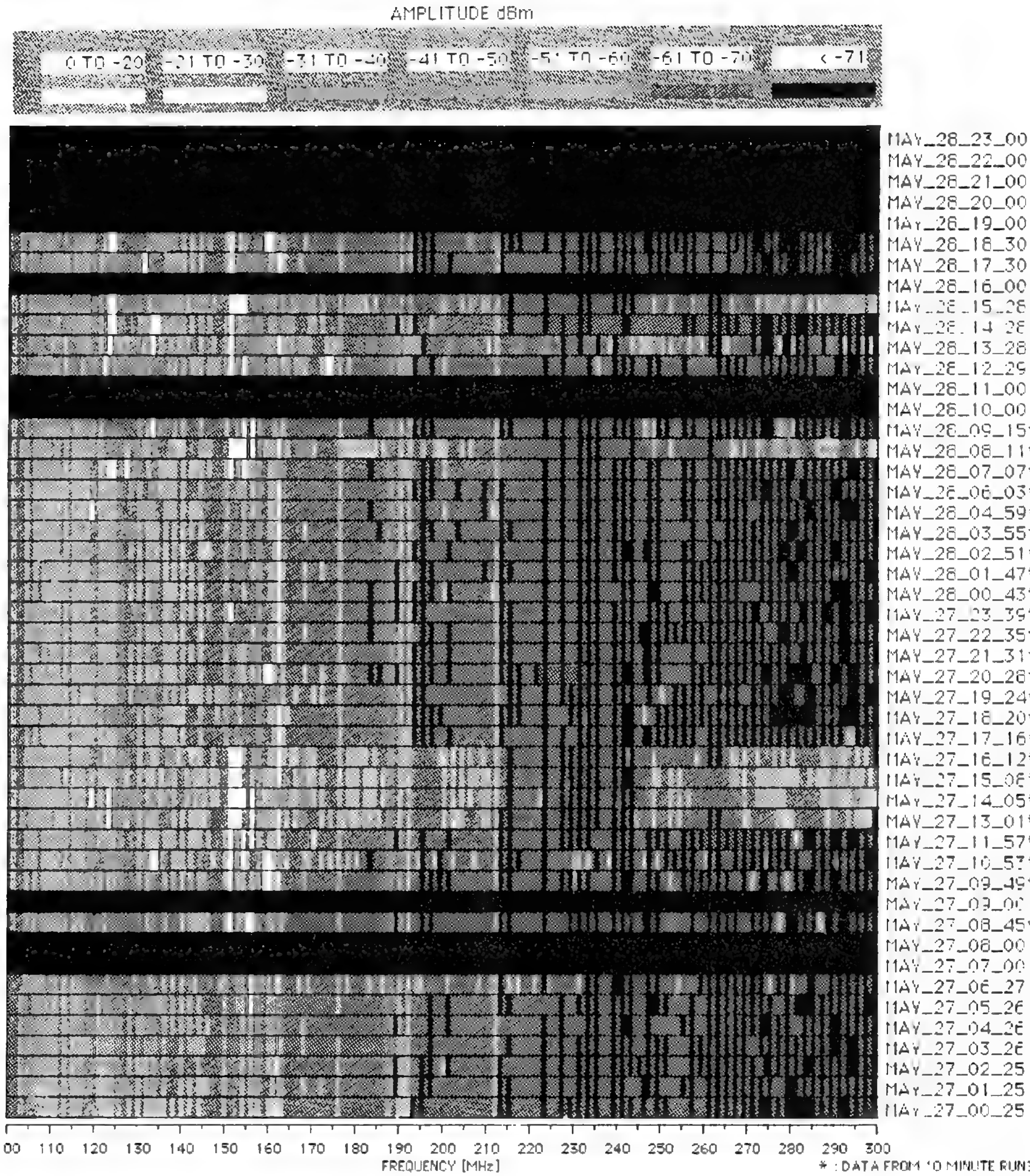

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
MAY_28_23_00
MAY_28_22_00
MAY_28_21_00
MAY_28_20_00
MAY_28_19_00
MAY_28_18_30
MAY_28_17_30
MAY_28_16_00
MAY_28_15_28
MAY_28_14_28
MAY_28_13_28
MAY_28_12_29
MAY_28_11_00
MAY_28_10_00
MAY_28_09_15*
MAY_28_08_11*
MAY_28_07_07*
MAY_28_06_03*
MAY_28_04_59*
MAY_28_03_55*
MAY_28_02_51*
MAY_28_01_47*
MAY_28_00_43*
MAY_27_23_39*
MAY_27_22_35*
MAY_27_21_31*
MAY_27_20_28*
MAY_27_19_24*
MAY_27_18_20*
MAY_27_17_16*
MAY_27_16_12*
MAY_27_15_08*
MAY_27_14_05*
MAY_27_13_01*
MAY_27_11_57*
MAY_27_10_53*
MAY_27_09_49*
MAY_27_09_00
MAY_27_08_45*
MAY_27_08_00
MAY_27_07_00
MAY_27_06_27
MAY_27_05_26
MAY_27_04_26
MAY_27_03_26
MAY_27_02_25
MAY_27_01_25
MAY_27_00_25
100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300
FREQUENCY [MHz]
* : DATA FROM 10 MINUTE RUNS

FIGURE 24

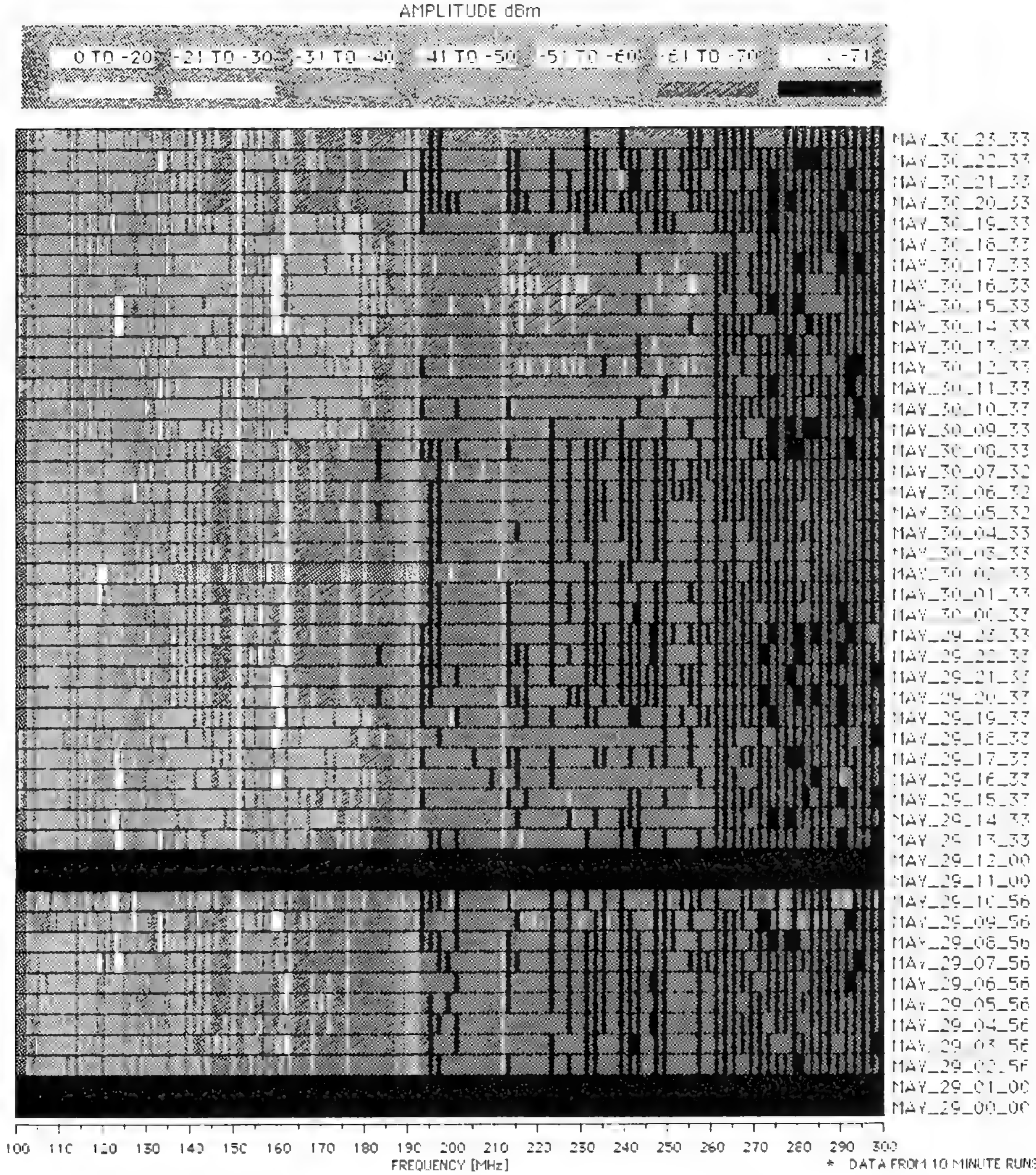

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
-71
MAY_30_23_33
MAY_30_22_33
MAY_30_21_33
MAY_30_20_33
MAY_30_19_33
MAY_30_18_33
MAY_30_17_33
MAY_30_16_33
MAY_30_15_33
MAY_30_14_33
MAY_30_13_33
MAY_30_12_33
MAY_30_11_33
MAY_30_10_33
MAY_30_09_33
MAY_30_08_33
MAY_30_07_32
MAY_30_06_32
MAY_30_05_32
MAY_30_04_33
MAY_30_03_33
MAY_30_02_33
MAY_30_01_33
MAY_30_00_33
MAY_29_23_33
MAY_29_22_33
MAY_29_21_33
MAY_29_20_33
MAY_29_19_33
MAY_29_18_33
MAY_29_17_33
MAY_29_16_33
MAY_29_15_33
MAY_29_14_33
MAY_29_13_33
MAY_29_12_00
MAY_29_11_00
MAY_29_10_56
MAY_29_09_56
MAY_29_08_56
MAY_29_07_56
MAY_29_06_56
MAY_29_05_56
MAY_29_04_56
MAY_29_03_56
MAY_29_02_56
MAY_29_01_00
MAY_29_00_00
100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300
FREQUENCY [MHz]
* DATA FROM 10 MINUTE RUNS

FIGURE 25

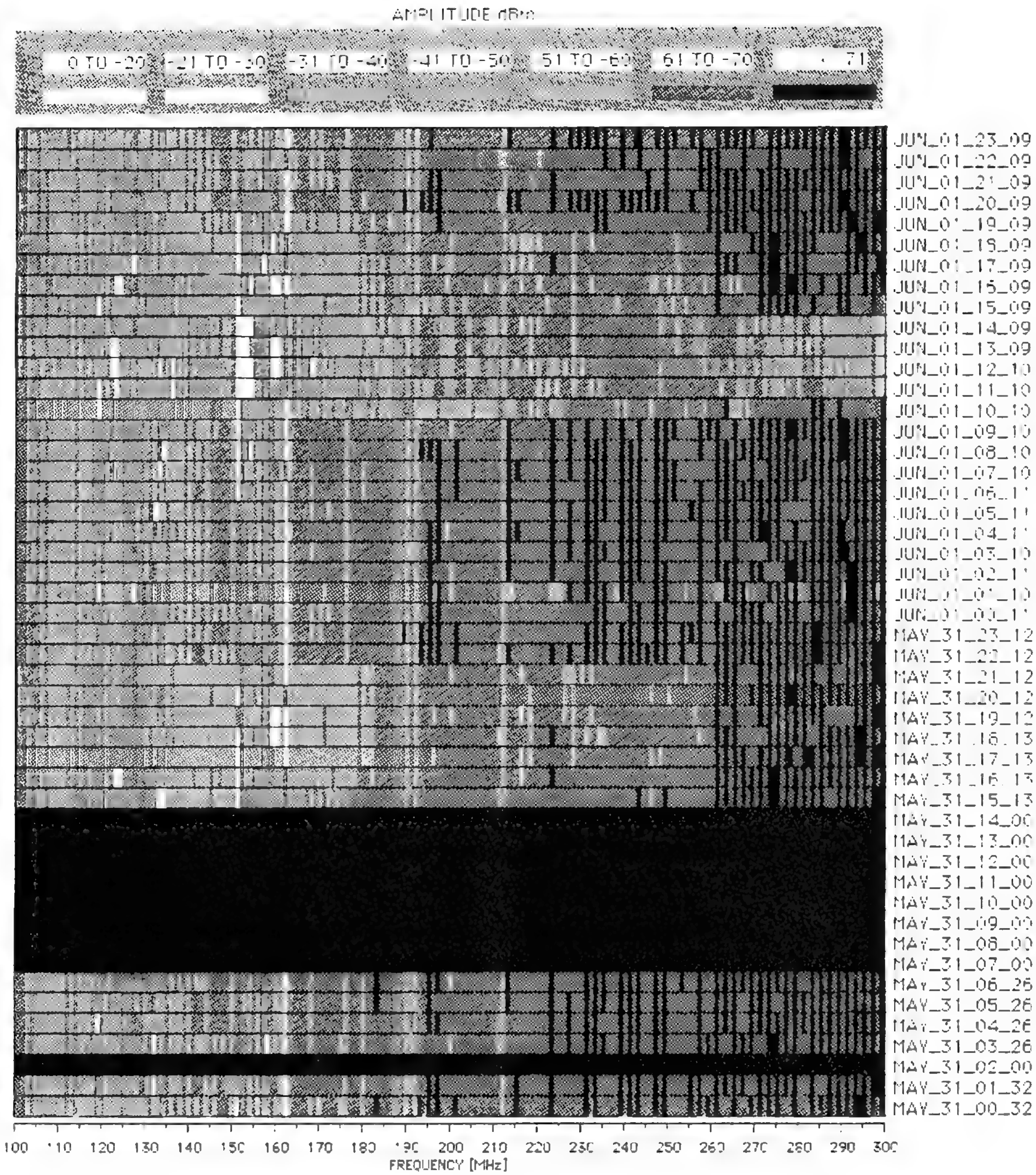

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
FREQUENCY [MHz]
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300

FIGURE 26

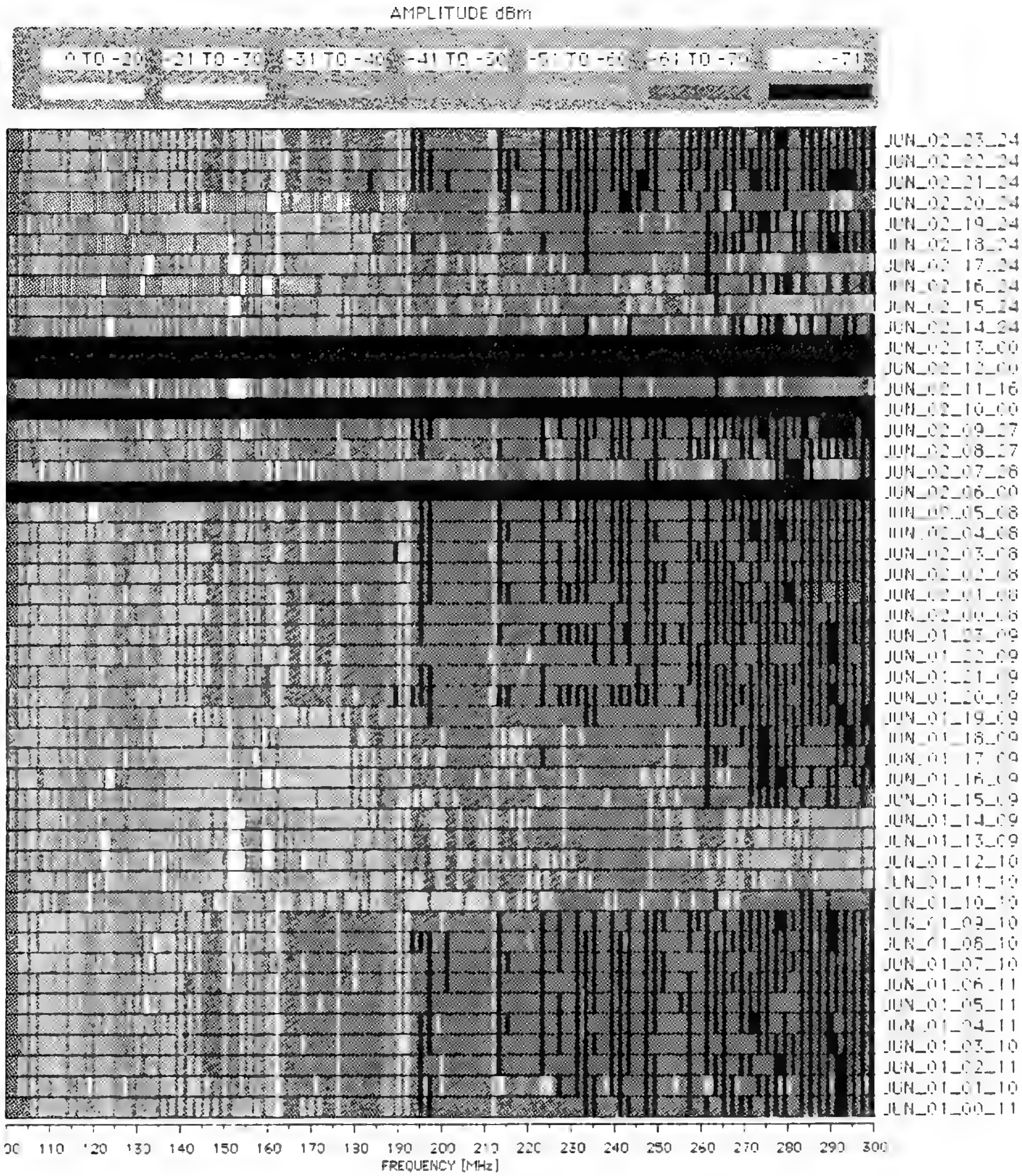

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
FREQUENCY [MHz]
100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300

FIGURE 27

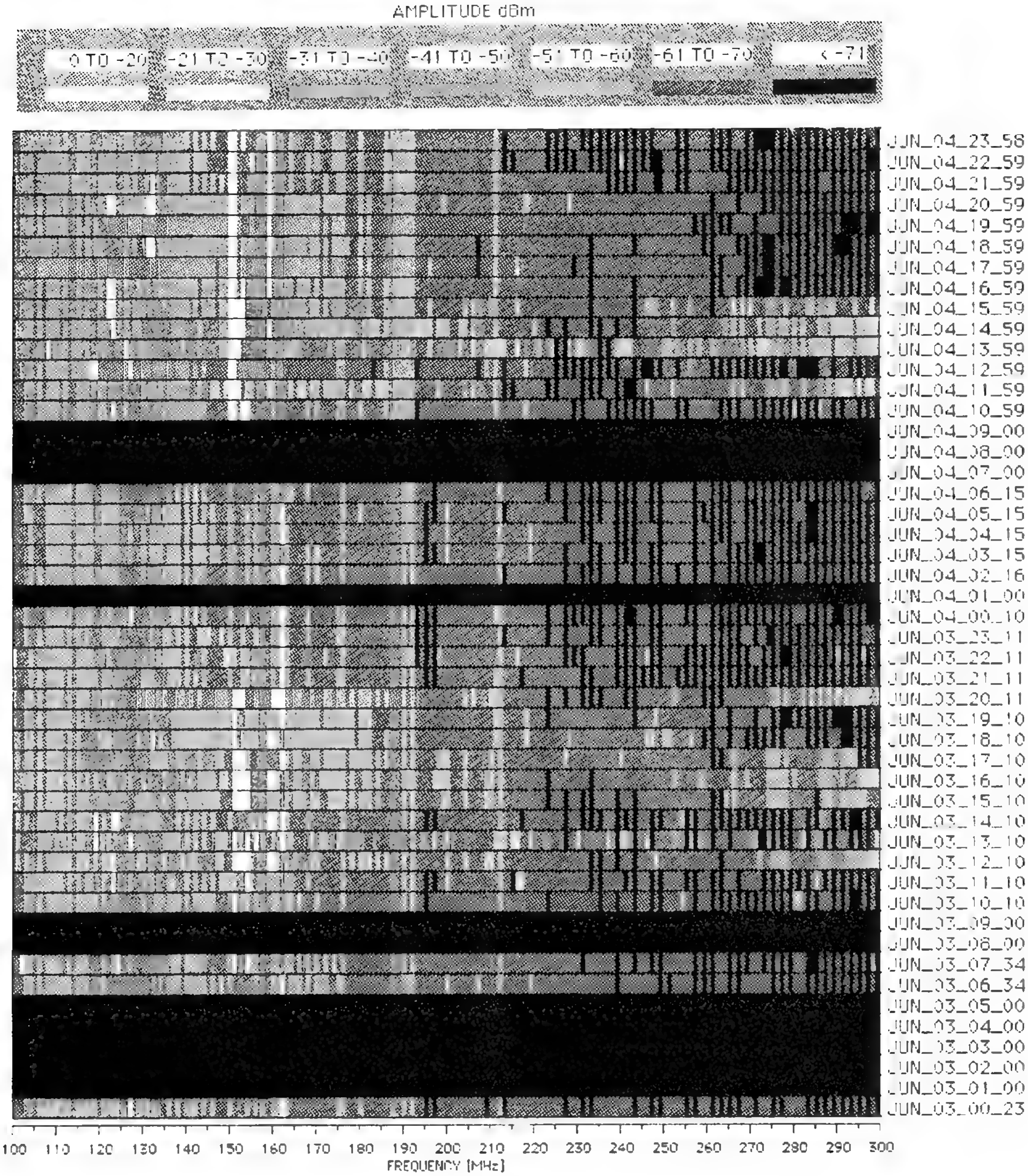

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
JUN_04_23_58
JUN_04_22_59
JUN_04_21_59
JUN_04_20_59
JUN_04_19_59
JUN_04_18_59
JUN_04_17_59
JUN_04_16_59
JUN_04_15_59
JUN_04_14_59
JUN_04_13_59
JUN_04_12_59
JUN_04_11_59
JUN_04_10_59
JUN_04_09_00
JUN_04_08_00
JUN_04_07_00
JUN_04_06_15
JUN_04_05_15
JUN_04_04_15
JUN_04_03_15
JUN_04_02_16
JUN_04_01_00
JUN_04_00_10
JUN_03_23_11
JUN_03_22_11
JUN_03_21_11
JUN_03_20_11
JUN_03_19_10
JUN_03_18_10
JUN_03_17_10
JUN_03_16_10
JUN_03_15_10
JUN_03_14_10
JUN_03_13_10
JUN_03_12_10
JUN_03_11_10
JUN_03_10_10
JUN_03_09_00
JUN_03_08_00
JUN_03_07_34
JUN_03_06_34
JUN_03_05_00
JUN_03_04_00
JUN_03_03_00
JUN_03_02_00
JUN_03_01_00
JUN_03_00_23
100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300
FREQUENCY (MHz)

FIGURE 28

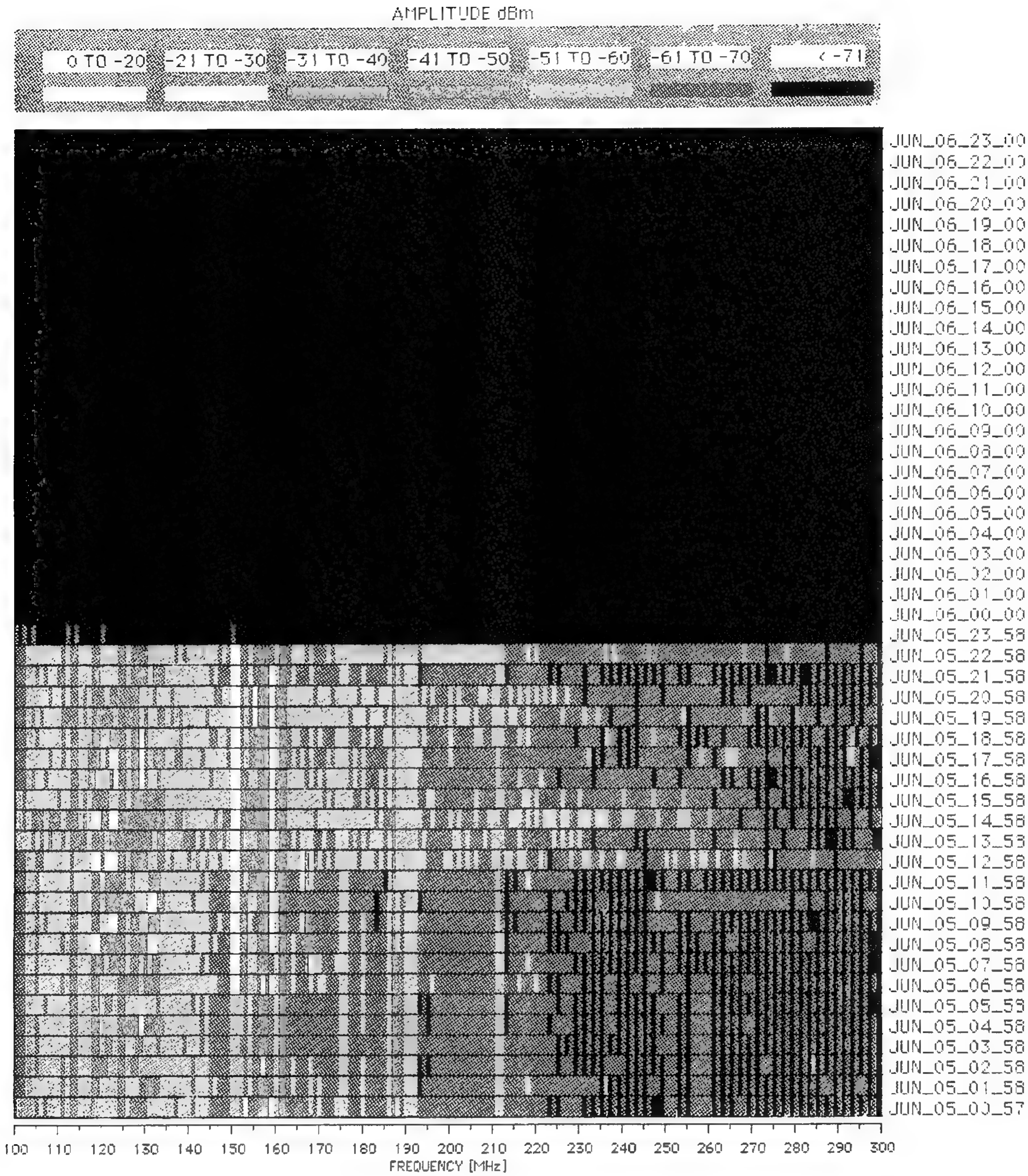
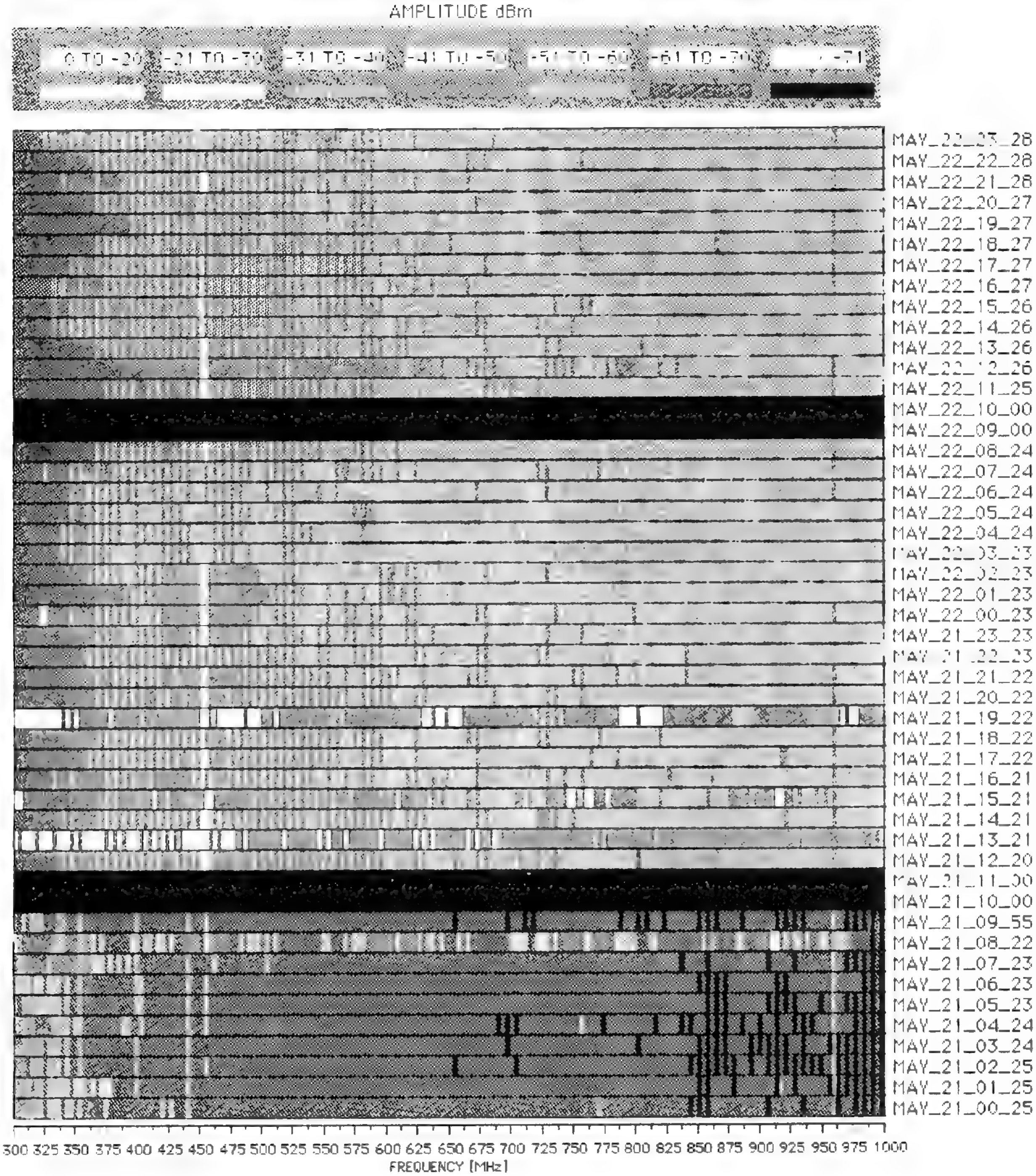

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
JUN_06_23_00
JUN_06_22_00
JUN_06_21_00
JUN_06_20_00
JUN_06_19_00
JUN_06_18_00
JUN_06_17_00
JUN_06_16_00
JUN_06_15_00
JUN_06_14_00
JUN_06_13_00
JUN_06_12_00
JUN_06_11_00
JUN_06_10_00
JUN_06_09_00
JUN_06_08_00
JUN_06_07_00
JUN_06_06_00
JUN_06_05_00
JUN_06_04_00
JUN_06_03_00
JUN_06_02_00
JUN_06_01_00
JUN_06_00_00
JUN_05_23_58
JUN_05_22_58
JUN_05_21_58
JUN_05_20_58
JUN_05_19_58
JUN_05_18_58
JUN_05_17_58
JUN_05_16_58
JUN_05_15_58
JUN_05_14_58
JUN_05_13_58
JUN_05_12_58
JUN_05_11_58
JUN_05_10_58
JUN_05_09_58
JUN_05_08_58
JUN_05_07_58
JUN_05_06_58
JUN_05_05_58
JUN_05_04_58
JUN_05_03_58
JUN_05_02_58
JUN_05_01_58
JUN_05_00_57
100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300
FREQUENCY [MHz]

FIGURE 29



AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
MAY_22_22_28
MAY_22_21_28
MAY_22_20_27
MAY_22_19_27
MAY_22_18_27
MAY_22_17_27
MAY_22_16_27
MAY_22_15_26
MAY_22_14_26
MAY_22_13_26
MAY_22_11_25
MAY_22_10_00
MAY_22_09_00
MAY_22_08_24
MAY_22_07_24
MAY_22_06_24
MAY_22_05_24
MAY_22_04_24
MAY_22_01_23
MAY_22_00_23
MAY_21_23_23
MAY_21_21_22
MAY_21_20_22
MAY_21_19_22
MAY_21_18_22
MAY_21_17_22
MAY_21_16_21
MAY_21_15_21
MAY_21_14_21
MAY_21_13_21
MAY_21_12_20
MAY_21_10_00
MAY_21_09_55
MAY_21_08_22
MAY_21_07_23
MAY_21_06_23
MAY_21_05_23
MAY_21_04_24
MAY_21_03_24
MAY_21_02_25
MAY_21_01_25
MAY_21_00_25
300 325 350 375 400 425 450 475 500 525 550 575 600 625 650 675 700 725 750 775 800 825 850 875 900 925 950 975 1000
FREQUENCY (MHz)

FIGURE 30

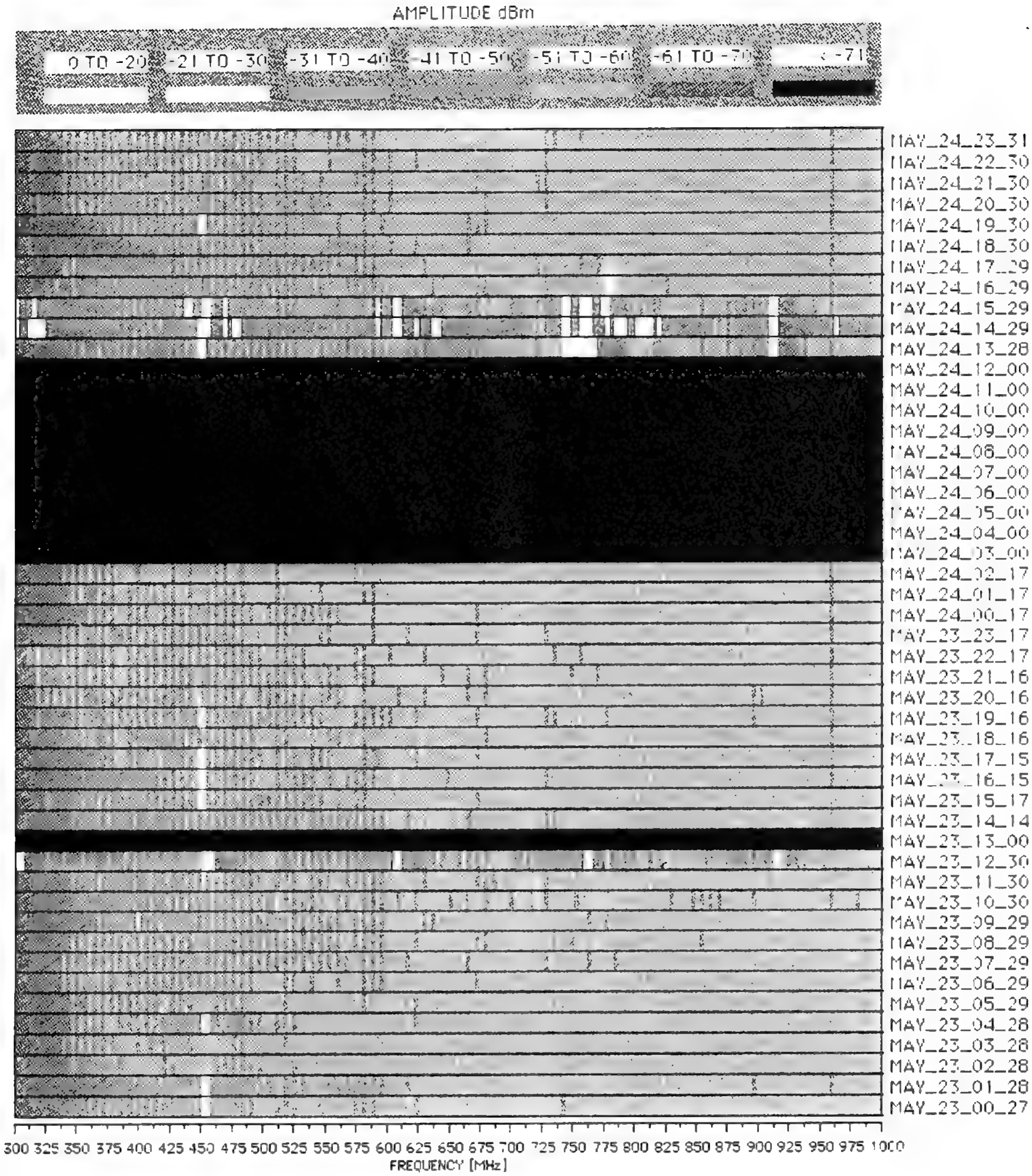

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
MAY_24_23_31
MAY_24_22_30
MAY_24_21_30
MAY_24_20_30
MAY_24_19_30
MAY_24_18_30
MAY_24_17_29
MAY_24_16_29
MAY_24_15_29
MAY_24_14_29
MAY_24_13_28
MAY_24_12_00
MAY_24_11_00
MAY_24_10_00
MAY_24_09_00
MAY_24_08_00
MAY_24_07_00
MAY_24_06_00
MAY_24_05_00
MAY_24_04_00
MAY_24_03_00
MAY_24_02_17
MAY_24_01_17
MAY_24_00_17
MAY_23_23_17
MAY_23_22_17
MAY_23_21_16
MAY_23_20_16
MAY_23_19_16
MAY_23_18_16
MAY_23_17_15
MAY_23_16_15
MAY_23_15_17
MAY_23_14_14
MAY_23_13_00
MAY_23_12_30
MAY_23_11_30
MAY_23_10_30
MAY_23_09_29
MAY_23_08_29
MAY_23_07_29
MAY_23_06_29
MAY_23_05_29
MAY_23_04_28
MAY_23_03_28
MAY_23_02_28
MAY_23_01_28
MAY_23_00_27
300 325 350 375 400 425 450 475 500 525 550 575 600 625 650 675 700 725 750 775 800 825 850 875 900 925 950 975 1000
FREQUENCY [MHz]

FIGURE 31

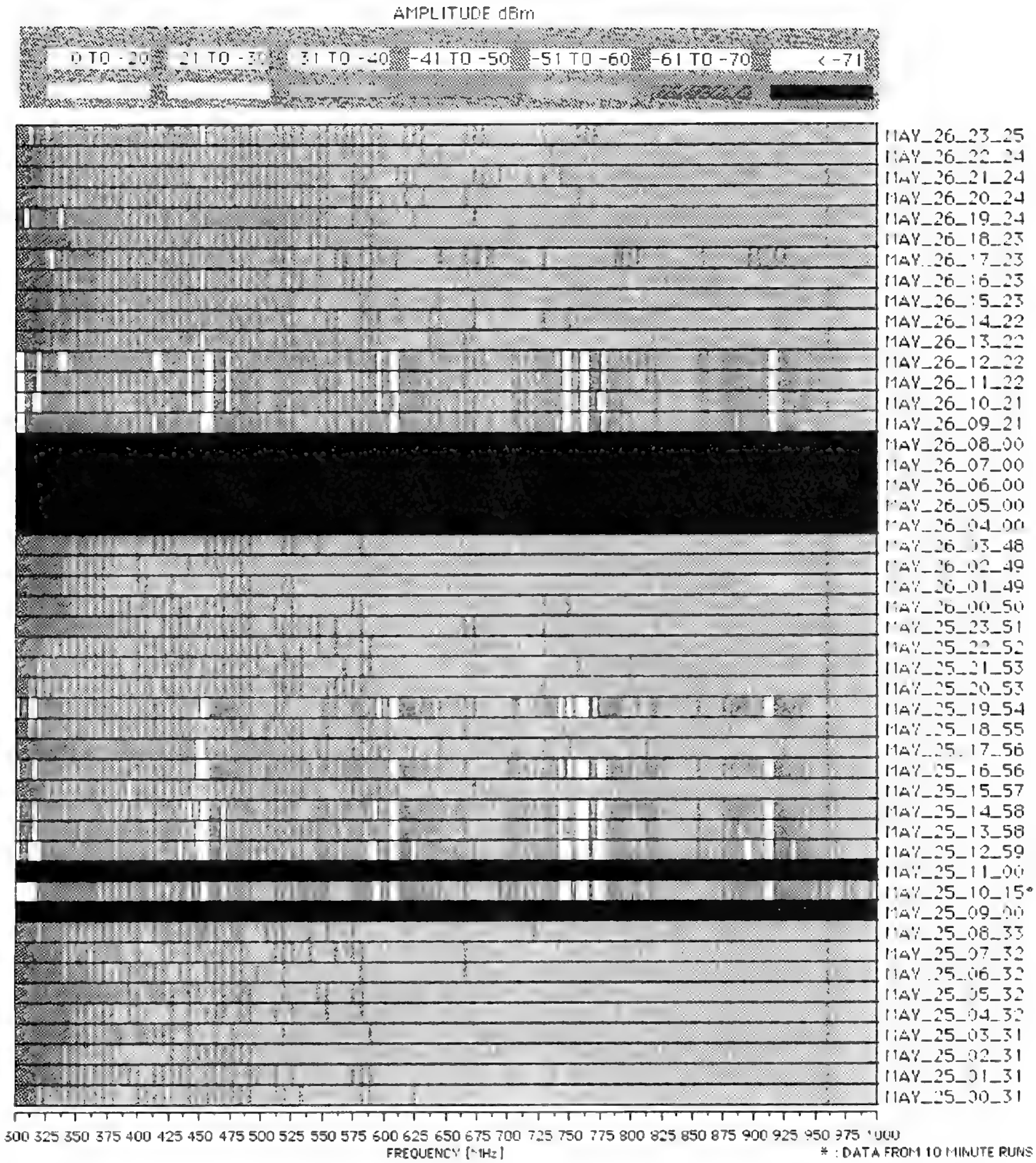

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
MAY_26_23_25
MAY_26_22_24
MAY_26_21_24
MAY_26_20_24
MAY_26_19_24
MAY_26_18_23
MAY_26_17_23
MAY_26_16_23
MAY_26_15_23
MAY_26_14_22
MAY_26_13_22
MAY_26_12_22
MAY_26_11_22
MAY_26_10_21
MAY_26_09_21
MAY_26_08_00
MAY_26_07_00
MAY_26_06_00
MAY_26_05_00
MAY_26_04_00
MAY_26_03_48
MAY_26_02_49
MAY_26_01_49
MAY_26_00_50
MAY_25_23_51
MAY_25_22_52
MAY_25_21_53
MAY_25_20_53
MAY_25_19_54
MAY_25_18_55
MAY_25_17_56
MAY_25_16_56
MAY_25_15_57
MAY_25_14_58
MAY_25_13_58
MAY_25_12_59
MAY_25_11_00
MAY_25_10_15*
MAY_25_09_00
MAY_25_08_33
MAY_25_07_32
MAY_25_06_32
MAY_25_05_32
MAY_25_04_32
MAY_25_03_31
MAY_25_02_31
MAY_25_01_31
MAY_25_00_31
300 325 350 375 400 425 450 475 500 525 550 575 600 625 650 675 700 725 750 775 800 825 850 875 900 925 950 975 1000
FREQUENCY [MHz]
* : DATA FROM 10 MINUTE RUNS

FIGURE 32

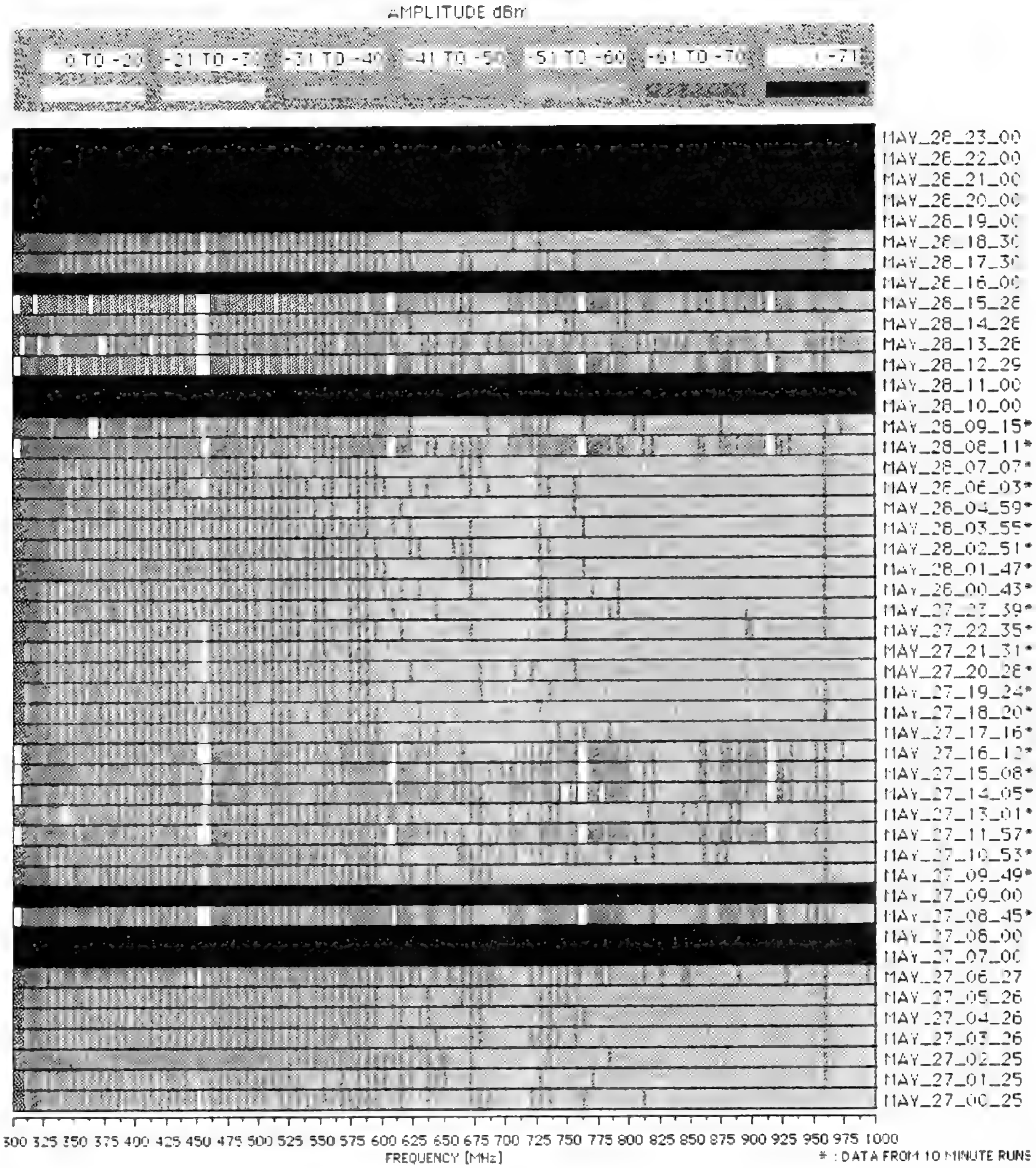

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
-71
MAY_28_23_00
MAY_28_22_00
MAY_28_21_00
MAY_28_20_00
MAY_28_19_00
MAY_28_18_30
MAY_28_17_30
MAY_28_16_00
MAY_28_15_28
MAY_28_14_28
MAY_28_13_28
MAY_28_12_29
MAY_28_11_00
MAY_28_10_00
MAY_28_09_15*
MAY_28_08_11*
MAY_28_07_07*
MAY_28_06_03*
MAY_28_04_59*
MAY_28_03_55*
MAY_28_02_51*
MAY_28_01_47*
MAY_28_00_43*
MAY_27_23_39*
MAY_27_22_35*
MAY_27_21_31*
MAY_27_20_28*
MAY_27_19_24*
MAY_27_18_20*
MAY_27_17_16*
MAY_27_16_12*
MAY_27_15_08*
MAY_27_14_05*
MAY_27_13_01*
MAY_27_11_57*
MAY_27_10_53*
MAY_27_09_49*
MAY_27_09_00
MAY_27_08_45*
MAY_27_08_00
MAY_27_07_00
MAY_27_06_27
MAY_27_05_26
MAY_27_04_26
MAY_27_03_26
MAY_27_02_25
MAY_27_01_25
MAY_27_00_25
300 325 350 375 400 425 450 475 500 525 550 575 600 625 650 675 700 725 750 775 800 825 850 875 900 925 950 975 1000
FREQUENCY (MHz)
* : DATA FROM 10 MINUTE RUNS

FIGURE 33

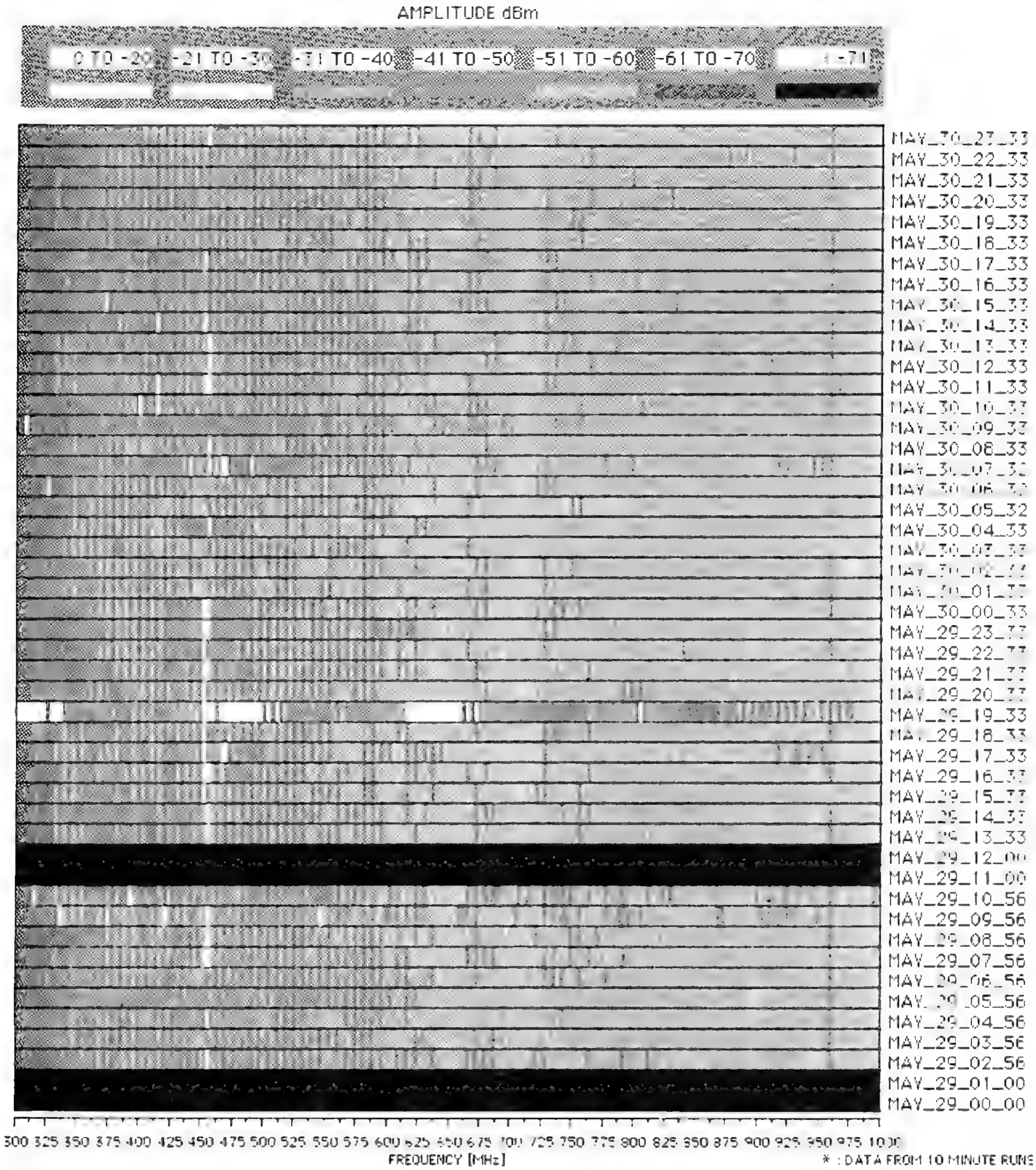

AMPLITUDE dBm
0 TO -20
-21 TO -30
-41 TO -50
-51 TO -60
-61 TO -70
MAY_30_22_33
MAY_30_21_33
MAY_30_20_33
MAY_30_19_33
MAY_30_18_33
MAY_30_17_33
MAY_30_16_33
MAY_30_12_33
MAY_30_11_33
MAY_30_08_33
MAY_30_05_32
MAY_30_04_33
MAY_30_00_33
MAY_29_21_33
MAY_29_19_33
MAY_29_17_33
MAY_29_13_33
MAY_29_11_00
MAY_29_10_56
MAY_29_09_56
MAY_29_07_56
MAY_29_04_56
MAY_29_03_56
MAY_29_02_56
MAY_29_01_00
MAY_29_00_00
FREQUENCY [MHz]
* : DATA FROM 10 MINUTE RUNS

FIGURE 34

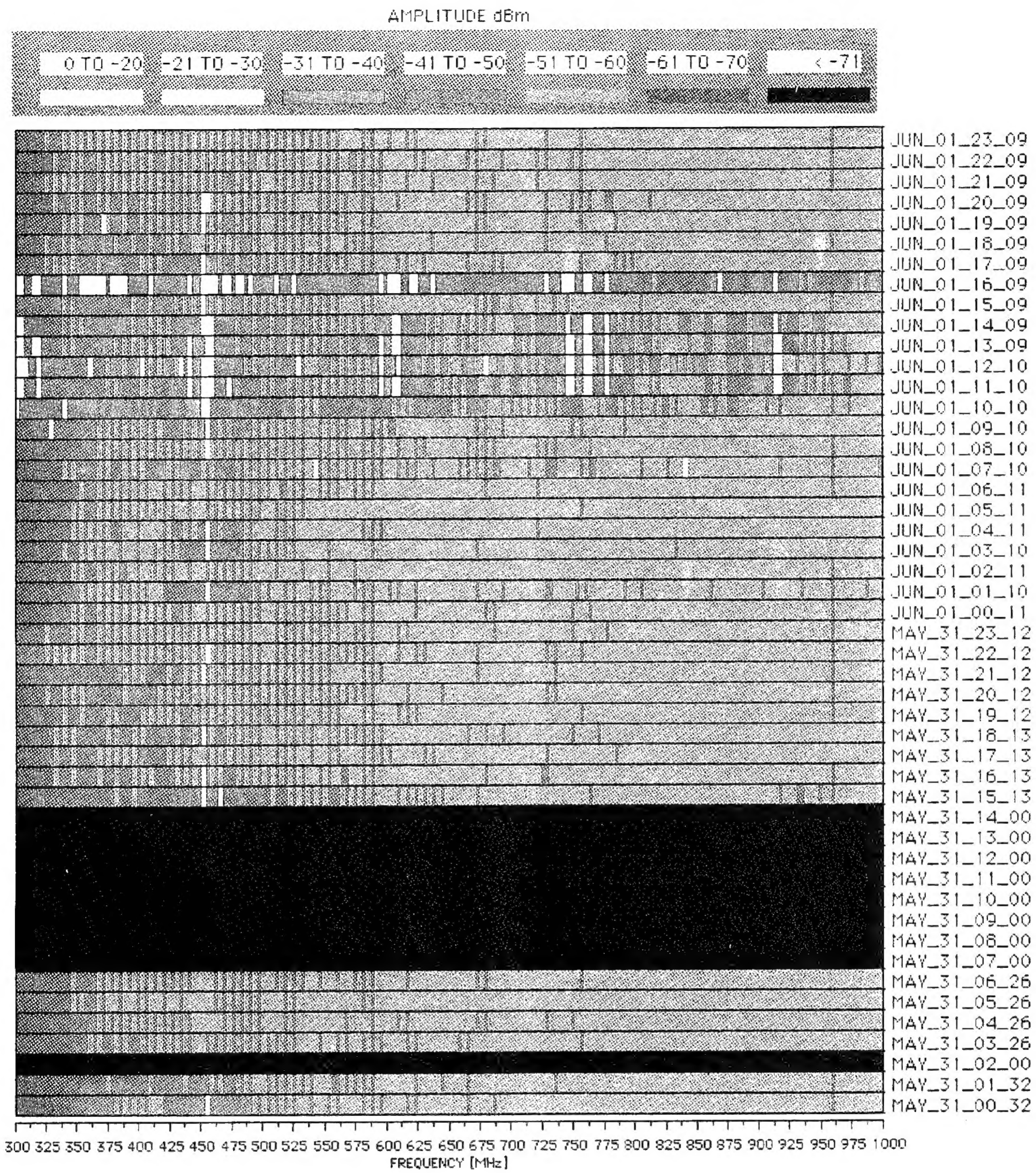
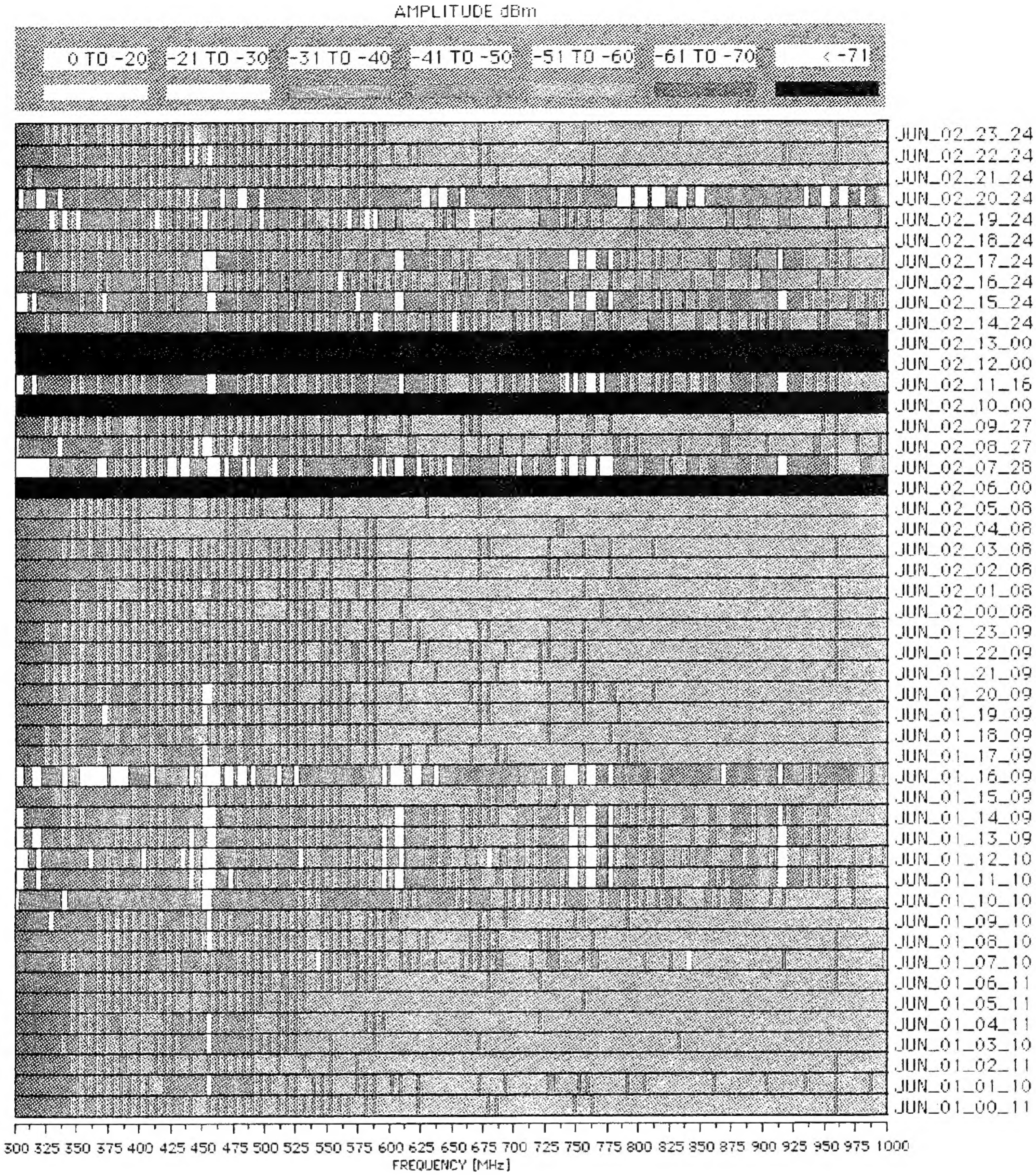
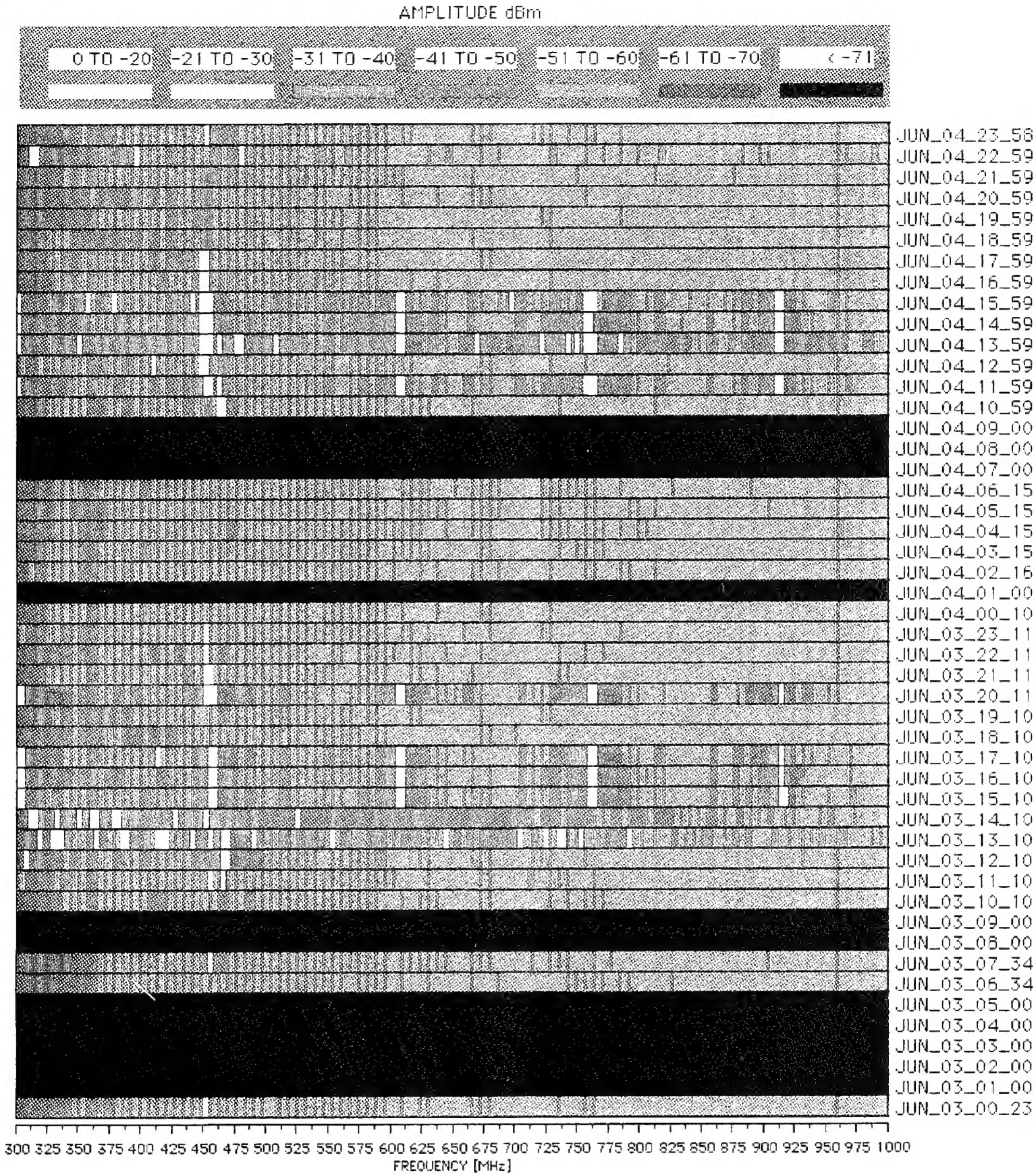

AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
JUN_01_23_09
JUN_01_22_09
JUN_01_21_09
JUN_01_20_09
JUN_01_19_09
JUN_01_18_09
JUN_01_17_09
JUN_01_16_09
JUN_01_15_09
JUN_01_14_09
JUN_01_13_09
JUN_01_12_10
JUN_01_11_10
JUN_01_10_10
JUN_01_09_10
JUN_01_08_10
JUN_01_07_10
JUN_01_06_11
JUN_01_05_11
JUN_01_04_11
JUN_01_03_10
JUN_01_02_11
JUN_01_01_10
JUN_01_00_11
MAY_31_23_12
MAY_31_22_12
MAY_31_21_12
MAY_31_20_12
MAY_31_19_12
MAY_31_18_13
MAY_31_17_13
MAY_31_16_13
MAY_31_15_13
MAY_31_14_00
MAY_31_13_00
MAY_31_12_00
MAY_31_11_00
MAY_31_10_00
MAY_31_09_00
MAY_31_08_00
MAY_31_07_00
MAY_31_06_26
MAY_31_05_26
MAY_31_04_26
MAY_31_03_26
MAY_31_02_00
MAY_31_01_32
MAY_31_00_32
300 325 350 375 400 425 450 475 500 525 550 575 600 625 650 675 700 725 750 775 800 825 850 875 900 925 950 975 1000
FREQUENCY [MHz]

FIGURE 35



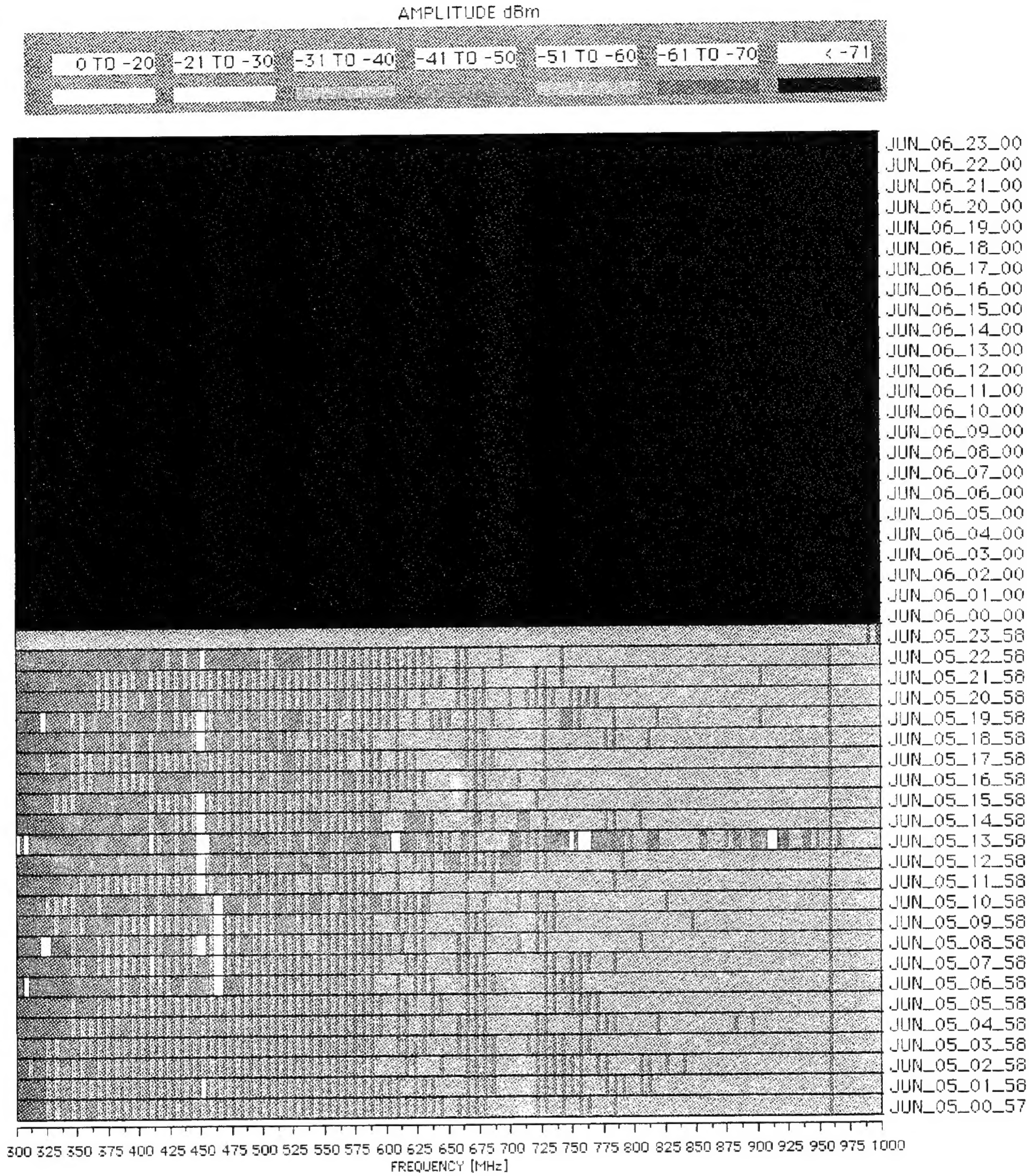
AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
JUN_02_23_24
JUN_02_22_24
JUN_02_21_24
JUN_02_20_24
JUN_02_19_24
JUN_02_18_24
JUN_02_17_24
JUN_02_16_24
JUN_02_15_24
JUN_02_14_24
JUN_02_13_00
JUN_02_12_00
JUN_02_11_16
JUN_02_10_00
JUN_02_09_27
JUN_02_08_27
JUN_02_07_28
JUN_02_06_00
JUN_02_05_08
JUN_02_04_08
JUN_02_03_08
JUN_02_02_08
JUN_02_01_08
JUN_02_00_08
JUN_01_23_09
JUN_01_22_09
JUN_01_21_09
JUN_01_20_09
JUN_01_19_09
JUN_01_18_09
JUN_01_17_09
JUN_01_16_09
JUN_01_15_09
JUN_01_14_09
JUN_01_13_09
JUN_01_12_10
JUN_01_11_10
JUN_01_10_10
JUN_01_09_10
JUN_01_08_10
JUN_01_07_10
JUN_01_06_11
JUN_01_05_11
JUN_01_04_11
JUN_01_03_10
JUN_01_02_11
JUN_01_01_10
JUN_01_00_11
300 325 350 375 400 425 450 475 500 525 550 575 600 625 650 675 700 725 750 775 800 825 850 875 900 925 950 975 1000
FREQUENCY [MHz]

FIGURE 36



AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
JUN_04_23_56
JUN_04_22_59
JUN_04_21_59
JUN_04_20_59
JUN_04_19_59
JUN_04_18_59
JUN_04_17_59
JUN_04_16_59
JUN_04_15_59
JUN_04_14_59
JUN_04_13_59
JUN_04_12_59
JUN_04_11_59
JUN_04_10_59
JUN_04_09_00
JUN_04_08_00
JUN_04_07_00
JUN_04_06_15
JUN_04_05_15
JUN_04_04_15
JUN_04_03_15
JUN_04_02_16
JUN_04_01_00
JUN_04_00_10
JUN_03_23_11
JUN_03_22_11
JUN_03_21_11
JUN_03_20_11
JUN_03_19_10
JUN_03_18_10
JUN_03_17_10
JUN_03_16_10
JUN_03_15_10
JUN_03_14_10
JUN_03_13_10
JUN_03_12_10
JUN_03_11_10
JUN_03_10_10
JUN_03_09_00
JUN_03_08_00
JUN_03_07_34
JUN_03_06_34
JUN_03_05_00
JUN_03_04_00
JUN_03_03_00
JUN_03_02_00
JUN_03_01_00
JUN_03_00_23
300 325 350 375 400 425 450 475 500 525 550 575 600 625 650 675 700 725 750 775 800 825 850 875 900 925 950 975 1000
FREQUENCY [MHz]

FIGURE 37



AMPLITUDE dBm
0 TO -20
-21 TO -30
-31 TO -40
-41 TO -50
-51 TO -60
-61 TO -70
< -71
JUN_06_23_00
JUN_06_22_00
JUN_06_21_00
JUN_06_20_00
JUN_06_19_00
JUN_06_18_00
JUN_06_17_00
JUN_06_16_00
JUN_06_15_00
JUN_06_14_00
JUN_06_13_00
JUN_06_12_00
JUN_06_11_00
JUN_06_10_00
JUN_06_09_00
JUN_06_08_00
JUN_06_07_00
JUN_06_06_00
JUN_06_05_00
JUN_06_04_00
JUN_06_03_00
JUN_06_02_00
JUN_06_01_00
JUN_06_00_00
JUN_05_23_58
JUN_05_22_58
JUN_05_21_58
JUN_05_20_58
JUN_05_19_58
JUN_05_18_58
JUN_05_17_58
JUN_05_16_58
JUN_05_15_58
JUN_05_14_58
JUN_05_13_58
JUN_05_12_58
JUN_05_11_58
JUN_05_10_58
JUN_05_09_58
JUN_05_08_58
JUN_05_07_58
JUN_05_06_58
JUN_05_05_58
JUN_05_04_58
JUN_05_03_58
JUN_05_02_58
JUN_05_01_58
JUN_05_00_57
300 325 350 375 400 425 450 475 500 525 550 575 600 625 650 675 700 725 750 775 800 825 850 875 900 925 950 975 1000
FREQUENCY [MHz]

FIGURE 38